

Article

Use of the Spatial Economic Benefit Analysis (SEBA) for Marine Spatial Planning: A Case Including Offshore Wind Energy and Fisheries in France

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Abstract

Marine Spatial Planning (MSP) is a key instrument for sustainable ocean governance in Europe, yet the spatial distribution of socioeconomic benefits and trade-offs remains poorly documented. This study applies and extends the Spatial Economic Benefit Analysis (SEBA) framework to offshore wind energy and capture fisheries in France, with a focus on the North Atlantic–Western Channel (NAMO) façade. Three extensions are introduced relative to earlier single-sector, single-scale SEBA applications: simultaneous dual-sector comparison, nesting of project-level firm mapping within regional analysis, and delivery through an open, updatable visualization platform that allows planners to re-run the analysis as registries are updated. Twelve indicator families were selected against four explicit criteria (relevance to a SEBA step, spatial attributability, traceability to a planning instrument, and public availability) and cross-validated against independent registries. Offshore wind employment is more unevenly distributed across regions than fishery revenue (Gini 0.59 versus 0.42), and firm presence is a weak proxy for employment: Brittany hosts 26.6% of mapped offshore wind firms but only 6.5% of sectoral full-time equivalents (2.1 FTE per firm), whereas Île-de-France hosts 4.8% of firms and 19.6% of employment (34.6 FTE per firm). Fishery revenue and offshore wind firm counts are positively rank-correlated across coastal regions (Spearman $\rho = 0.90$, $n = 5$, $p = 0.037$), indicating co-location rather than causation: offshore wind constitutes an additional spatial pressure on a sector already contracting (−9.5% employment 2012–2022; −29% vessels 2000–2023). Uncertainty was addressed through a three-tier data confidence classification and sensitivity testing; concentration rankings were robust to extreme reassignments of multi-role firms ($\Delta\text{Gini} \leq 0.06$). The analysis is deliberately restricted to the distribution of economic benefits and does not assess ecological impacts, which must be integrated before SEBA outputs inform zoning. Outputs are directly interpretable for façade plan revision, tender local content scoring, and compensation design, and the workflow is transferable to any jurisdiction with public corporate registries and landings statistics.



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1. Introduction

Marine Spatial Planning (MSP) constitutes a comprehensive ecosystem-based governance framework aimed at organizing the spatial and temporal allocation of marine resources and activities to ensure environmental sustainability and socioeconomic equity [1–3]. MSP is embedded within European legislative frameworks, notably the Water Framework Directive (2000/60/EC), Marine Strategy Framework Directive (2008/56/EC), and Maritime Spatial Planning Directive (2014/89/EU), which collectively mandate integrated maritime governance balancing ecological integrity, economic development, and social considerations [2,4–6]. A defining feature of MSP is its participatory methodology, which incorporates diverse stakeholder knowledge from governmental bodies and industry actors to coastal communities and NGOs, thus enhancing both technical robustness and social legitimacy [7–9].

Technological advances in geospatial analysis, remote sensing, and data visualization have markedly improved the capacity of MSP to assess spatial trends, cumulative environmental impacts, and future use scenarios [10]. Spatial Economic Benefit Analysis (SEBA) has demonstrated utility in Baltic MSP contexts. However, it has not been operationalized for simultaneous dual-sector comparison, such as offshore wind versus fisheries, in settings that lack a centralized marine economic database. This gap constrains distributive equity assessment. Distributive equity assessment asks whether economic benefits accrue proportionally to the communities that bear the associated environmental and spatial burdens. Answering that question requires evidence on where sectoral benefits concentrate relative to impact zones, which French planners currently lack [11,12]. Prior SEBA applications, for example Schultz-Zehden et al. [13], addressed single sectors such as shipping or aquaculture at a single, national scale.

The normative framework of MSP increasingly foregrounds social justice principles, emphasizing the recognition, representation, and equitable distribution of marine benefits and burdens [14]. This shift aligns with the United Nations Sustainable Development Goals (SDGs), particularly SDG 14 (“Life Below Water”), which focuses on the conservation and sustainable use of oceans, seas, and marine resources, in conjunction with broader goals for sustainable development. Despite the EU-wide requirement for maritime spatial plans by 2021, implementation has varied significantly across Member States, shaped by governance structures, regional conditions, and political priorities, with implications for policy integration and effectiveness [15].

The accelerating expansion of offshore renewable energy (ORE), particularly offshore wind, alongside traditional maritime sectors such as fisheries, shipping, and tourism, intensifies spatial competition and necessitates enhanced cross-sectoral coordination and governance integration [16,17]. MSP facilitates this transition by providing spatial clarity, legal certainty, and platforms for stakeholder dialogue, streamlining decision-making and mitigating user conflicts [18]. Empirical examples from Germany, the Netherlands, and the United Kingdom demonstrate the MSP’s role in enabling rapid offshore wind deployment while balancing marine conservation objectives [19]. Nonetheless, economic assessments of the MSP’s impact on regional development and the blue economy remain underdeveloped, underscoring the need for improved socioeconomic evaluation frameworks [20].

Recent work has sharpened the terms of this debate. Trifonova et al. [21] argue that the pace of offshore wind expansion risks substituting one environmental crisis for another unless spatial displacement of fishing effort is modelled alongside ecosystem change, and Szostek et al. [22] document how the resulting spatial squeeze has reversed the previously neutral or positive attitudes of fishers towards offshore wind farms. Comparative governance research shows that the resolution of such conflicts depends less on the spatial plan itself than on the permitting instruments that follow it, with Denmark, England, and the

Netherlands adopting markedly different measures under nominally similar MSP obligations [23]. Methodologically, spatially explicit Bayesian networks have been introduced to propagate uncertainty in the economic effects of competing uses on Adriatic fisheries [24], while evidence quality reviews warn that much of the offshore wind impact literature rests on grey sources of uneven reliability [25]. For France specifically, Guyot-Téphany et al. [26] find that participation in the façade planning process has satisfied formal requirements while delivering limited substantive influence. Collectively, the literature identifies displacement, uncertainty, and procedural thinness as the live problems; none of it maps where the economic benefits of the expanding sector actually accrue, which is the gap addressed here.

Effective MSP integration relies on the deliberate selection and strategic application of planning and decision support tools (DSTs) tailored to specific objectives, institutional capacities, data availability, and stakeholder contexts [27,28]. These tools range from problem-focused spatial analyses, such as Marxan and SEBA, to process-oriented instruments that foster stakeholder engagement and knowledge co-production [29,30]. SEBA addresses socioeconomic integration gaps by spatially mapping economic beneficiaries across marine sectors and supporting multidimensional integration encompassing knowledge, stakeholder, policy, land–sea, and transboundary considerations [13]. Its application to offshore wind and fisheries in France revealed spatial economic patterns that are essential for an inclusive, data-driven MSP.

Positioning SEBA Among Socioeconomic Assessment Approaches in MSP

The contribution of this study is not the invention of a new metric but the demonstration that a distributive question, largely unanswered in MSP practice, can be answered with data that planning authorities already hold. Making that argument requires positioning SEBA against the alternatives (Table 1). Socioeconomic assessment in MSP has been dominated by two families of methods. The first, comprising cost–benefit analysis and input–output or computable general equilibrium modelling, produces aggregate welfare or multiplier estimates [20]. These are analytically powerful but spatially blind: they report how much value a sector generates, not where that value lands or who receives it. The second family, comprising spatial conservation prioritization, cumulative-effects assessment, and, more recently, spatially explicit Bayesian network models of fishery economics, is highly spatial but organized around costs, pressures, or impacts on an incumbent sector. Both families therefore leave the beneficiary side of a new maritime use largely unmapped.

SEBA occupies the empty cell in this matrix. It is spatially explicit, sector-agnostic, and beneficiary-oriented: it asks which firms, workers, and institutions capture value from a marine activity and in which territory they are located. Three properties make it particularly suited to analyzing spatial equity and sectoral trade-offs. First, it is comparative by construction, because the same beneficiary unit (a firm or a full-time equivalent job) can be counted for a capital-intensive emerging sector and for a labour-intensive incumbent one, which aggregate monetary indicators cannot do without heroic assumptions about shadow prices. Second, it is low in data intensity relative to its spatial resolution, drawing on corporate registries and landings statistics that are public in most European jurisdictions; this matters where, as in France, no centralized marine socioeconomic repository exists. Third, its outputs are legible to non-technical stakeholders, which is a precondition for the deliberative function that MSP tools are increasingly expected to perform.

Conceptually, the study is framed by the tripartite conception of justice that has become the reference point for normative MSP scholarship: distribution, recognition, and procedure [14]. SEBA speaks directly to the distributive dimension by making the geography of benefit visible and therefore contestable. It speaks indirectly to recognition,

because a sector whose economic footprint is unmapped is structurally easier to treat as residual in zoning decisions. It does not, on its own, address procedure; that limitation is examined in Section 4.5. This framing explains why the analysis privileges the distribution of benefit over its magnitude, and why the comparison of two sectors, rather than the description of one, is the analytical core of the paper.

Table 1. Positioning of SEBA relative to other socioeconomic assessment approaches used in Marine Spatial Planning. Spatial explicitness and multi-sector comparability are assessed with respect to the distributive question addressed in this study.

Approach	Primary Output	Spatial Explicitness	Multi-Sector Comparability	Principal Limitation for Distributive Analysis
Cost–benefit analysis	Aggregate net present value of a plan or project	Low	Moderate	Aggregates gains and losses into a single figure, concealing who benefits and where
Input–output and computable general equilibrium modelling	Output, income, and employment multipliers	Low to moderate	High	Requires sector-consistent accounting tables that are rarely available at sub-national marine scale
Bioeconomic and Bayesian network models	Scenario projections of fleet revenue and effort	High	Low (fishery-centric)	Model the affected sector but not the beneficiary structure of the expanding sector
Spatial conservation prioritization (e.g., Marxan)	Optimized zoning solutions	Very high	Moderate	Optimizes ecological cost efficiency, not the distribution of economic benefit
Ecosystem service valuation	Monetised service flows	Moderate to high	Moderate	Value flows to society in aggregate; weak attribution to identifiable firms and workers
Cumulative-effects assessment	Pressure and impact layers	Very high	High	Burden-oriented by construction; benefits are not represented
Participatory and deliberative tools (e.g., Culturally Significant Areas, Open Standards)	Shared narratives and mapped values	Variable	Low	Outputs are not comparable across sectors and resist quantification
SEBA (as extended here)	Mapped distribution of economic beneficiaries by sector, role, and scale	High	High	Static and descriptive; sensitive to registered-address bias (see Sections 2.6 and 4.5)

France’s MSP framework, operationalized through Documents Stratégiques de Façade (DSF), mandates ecosystem-based planning across four maritime regions [31]. The 2022–2027 cycle prioritizes offshore wind expansion (target: 18 GW by 2035) while maintaining fishery access; however, socioeconomic trade-off analyses remain underdeveloped. MSP facilitates spatial coordination by delineating priority zones for offshore wind deployment, informed by scientific assessments and stakeholder consultations, thereby reducing conflicts with fisheries and protected areas. The integration of stakeholder engagement and regulatory streamlining aims to accelerate offshore wind projects while addressing the spatial constraints and socioeconomic challenges of fisheries.

The French fishery sector, integral to coastal livelihoods and cultural heritage, faces mounting pressure from spatial competition, environmental stressors, and socioeconomic

challenges [32–34]. The DSFs prioritize ecological and technical criteria but provide no spatially disaggregated employment or firm participation data for sectoral trade-off analysis [31]. This gap renders the localized economic contributions of fisheries invisible during offshore wind zoning decisions. MSP's role in fishery governance is critical for safeguarding access rights, promoting equitable spatial coexistence, and integrating socioeconomic valuation beyond traditional catch metrics [35]. The SEBA tool's capacity to spatially represent fisheries' economic contributions supports more balanced zoning scenarios and inclusive stakeholder participation, mitigating displacement risks, and fostering coexistence with emerging sectors.

This study employs the SEBA methodology to analyze the spatial economic dynamics of offshore wind and fisheries in France's North Atlantic–Western Channel region. By producing spatially explicit economic maps, it aims to elucidate the distribution of economic activities, employment, and firm participation, thereby advancing equitable and sustainable marine governance. The findings demonstrate SEBA's potential to enhance the socioeconomic integration of MSP, enabling planners to visualize trade-offs, engage stakeholders transparently, and align policies with regional development objectives.

Three objectives follow. The first is to map, at both project and regional scale, the distribution of economic beneficiaries in the offshore wind and capture fishery sectors of mainland France. The second is to compare the two distributions quantitatively, using concentration and co-location statistics rather than visual inspection alone. The third is to assess what such evidence can and cannot contribute to French MSP practice. The scope is deliberately bounded: the analysis concerns the distribution of economic benefit and does not evaluate ecological impact, carbon abatement, cultural value, or the non-market dimensions of either sector. SEBA outputs are consequently a complement to, not a substitute for, the environmental assessments that already dominate French façade planning, and they should not be used to justify zoning decisions in isolation. The implications of this boundary are returned to in Section 4.5.

2. Methodology

This study employs a mixed-method approach grounded in the SEBA framework to comprehensively evaluate the socioeconomic dimensions of MSP in France, with a particular focus on the North Atlantic–Western Channel (NAMO) façade. Originally developed within the BONUS BaltSpace project [13], the SEBA addresses integration challenges in MSP by providing a spatialized representation of economic benefits, stakeholder linkages, and value chains. This study adapts and operationalizes the SEBA to simultaneously analyze two key marine sectors, offshore wind energy and capture fisheries, at both national and regional scales, thereby bridging the gap between ecological spatial data and socioeconomic datasets that are often aggregated, non-spatial, or decontextualized.

The SEBA framework follows a structured six-step process: **(1) sector analysis, (2) brainstorming, (3) data collection, (4) database development, (5) spatial mapping, and (6) map interpretation.** This methodology facilitates an assessment of where and for whom socioeconomic benefits are generated, which is a prerequisite for achieving spatial equity and fostering informed stakeholder dialogue in MSP.

2.1. Sectoral Scope and Analytical Framework

The analysis focused on two sectors: offshore wind energy and capture fisheries. Each sector was approached with distinct yet complementary methods adapted to the SEBA framework.

2.1.1. Offshore Wind Sector

The offshore wind sector analysis comprises two complementary layers addressing distinct scalar questions: (1) Project-level mapping (Saint-Brieuc, Saint-Nazaire, and Yeu–Noirmoutier) reveals how benefits are distributed within developments, local content integration, subcontractor participation, and transnational dependencies, informing project-specific equity audits. (2) National-level mapping (all French offshore wind firms) reveals where ecosystems cluster (Île-de-France headquarters vs. Normandy ports), thereby informing regional policy. This scalar integration is a methodological innovation: prior SEBA studies [13] analyzed single scales, missing nested equity patterns in their analyses.

The offshore wind sector analysis comprises two complementary layers.

1. **Wind Farm-Specific Enterprise Mapping:** This layer targets three major offshore wind projects in the NAMO region: *Yeu–Noirmoutier*, *Saint-Nazaire*, and *Saint-Brieuc*. Firm-level data were collected for each project, categorizing enterprises by nationality and functional role (e.g., developers, EPC contractors, OEMs, consultants, logistics providers). Spatial maps were generated to visualize the distribution of these firms, highlighting transboundary economic linkages, power asymmetries, and the extent of local content integration, defined as the proportion of project employment (FTEs) and contract value accruing to firms within 100 km of turbine sites (following [36]) within project-level planning.
2. **National/Regional Offshore Wind Ecosystem Mapping:** A broader dataset was compiled to map all local enterprises involved in offshore wind across France, classified into eleven functional categories along the value chain, including developers, OEMs, component suppliers, consultants, EPC contractors, O&M service providers, marine logistics, financial institutions, institutional actors, research/training institutes, and tertiary services. Firms active in multiple roles ($n = 47$, 4.5% of the dataset) were assigned a dominant category using the following hierarchy: (1) self-reported primary activity in corporate registries (SIRENE database), (2) revenue share if disclosed ($\geq 60\%$ threshold), or (3) majority employee allocation per company profiles. Discrepancies were resolved via consensus review of annual reports. The spatial distribution of these firms was visualized at the regional scale to assess geographic clustering, local content integration, and economic spillovers.

2.1.2. Fishery Sector

The fishery sector was analyzed through a multi-dimensional spatial approach that diverges from traditional bioeconomic models. Instead of focusing solely on biomass or catch–effort ratios, this study treats fisheries as a socially embedded, spatially distributed system emphasizing structural vulnerability, market dependencies, and employment dynamics. Key parameters included:

- Regional quantity and economic value of fish landings (2023).
- Temporal changes in fleet structure (2000–2023), focusing on the decline of small-scale vessels.
- Financial performance indicators (net profit, gross margin, value-added) from 2016 to 2022.
- Employment distribution shifts (2012–2022).
- Spatial distribution of active auction centres (criées).

These indicators were spatially mapped and interpreted to assess economic footprints, infrastructural dependencies, and regional disparities within the fishery sector, thereby capturing socioeconomic legitimacy considerations relevant to MSP.

2.1.3. Indicator Selection and Alignment with the SEBA Framework

Indicators were not selected opportunistically from what happened to be available. Four criteria were applied in sequence, and an indicator was retained only if it satisfied all four. (i) Relevance to a SEBA step: the indicator had to feed one of the six steps of the framework, and indicators serving only descriptive purposes were excluded. (ii) Spatial attributability: the indicator had to be assignable to a defined spatial unit without imputation, which excluded, for example, national turnover figures reported by parent companies. (iii) Traceability to a planning instrument: the indicator had to correspond to a variable that a French planning authority can act upon, whether through zoning, tender design, fiscal allocation, or fund targeting. (iv) Public availability and reproducibility: no indicator relies on data obtained under confidentiality, so the full analysis can be replicated by third parties.

Applying these criteria produced twelve indicator families, six per sector, summarized in Table 2 together with the SEBA step and the type of integration each addresses in the typology of Schultz-Zehden et al. [13]. Two deliberate asymmetries in the indicator set should be noted. First, employment is measured in full-time equivalents in both sectors and is the single variable that permits direct quantitative comparison; all other indicators are sector-specific and are compared only in terms of their spatial distribution, not their magnitude. Second, the fishery indicator set is weighted towards vulnerability (fleet decline, financial performance, infrastructure loss), whereas the offshore wind set is weighted towards participation (firm counts, roles, nationality). This reflects the structural difference between a contracting sector, for which the planning-relevant question is exposure, and an expanding one, for which it is capture. It is not a neutral choice, and its consequences for interpretation are addressed in Section 2.8.

Table 2. Indicators retained for analysis, the SEBA step each serves, the type of integration it addresses, its source, and the reason for its selection. SEBA steps: 1 = sector analysis, 2 = brainstorming, 3 = data collection, 4 = database development, 5 = mapping, 6 = interpretation.

Indicator	Sector	SEBA Step	Integration Type	Principal Source	Selection Rationale
Landings volume by region (2023)	Fisheries	3–5	Knowledge	FranceAgriMer/ VISIOMer	Only regionalised measure of physical output published on a consistent basis
First-sale revenue by region (2023)	Fisheries	3–5	Knowledge; policy	FranceAgriMer/ VISIOMer	Monetary benefit captured at the point in the chain closest to the coastal community
Employment (FTE) by maritime zone, 2012–2022	Fisheries	3–5	Stakeholder	Agreste—Data Collection Framework	Identifies who depends on the contested space, and the direction of change
Fleet size and length class, 2000–2023	Fisheries	3–5	Knowledge	Agreste—Data Collection Framework	Separates place-bound small-scale capacity (<12 m) from mobile industrial capacity
Active fishing auction centres (criées)	Fisheries	5	Land–sea	FranceAgriMer/ VISIOMer	Fixed onshore infrastructure that ties a sea use to a specific coastal economy
GVA, gross margin and net profit, 2016–2022	Fisheries	3–6	Policy	Agreste—DCF; STECF	Establishes the financial baseline against which additional spatial pressure is judged

Table 2. *Cont.*

Indicator	Sector	SEBA Step	Integration Type	Principal Source	Selection Rationale
Installed and planned capacity, tender round, distance to shore	Offshore wind	1, 3	Policy	Ministère de la Transition Écologique; Éoliennes en Mer	Locates the spatial claim and its timing within the tendering pipeline
Firm counts by functional role and region (11 value chain categories)	Offshore wind	3–5	Knowledge; sector	SIRENE; France Énergies Marines; 4C Offshore	Core SEBA beneficiary variable; the unit that is directly comparable across sectors
Firm nationality at project level	Offshore wind	3–5	Transboundary	EIAs; operator disclosures	Measures the share of value that leaves the national economy
Local subcontractor directory (Yeu–Noirmoutier)	Offshore wind	3–5	Land–sea	EMYN operator disclosure, 2025	The only sub-regional benefit evidence in the public domain; used here for scale validation
Employment (FTE) by region, 2019–2024	Offshore wind	3–5	Stakeholder	Observatoire des énergies de la mer	Labour metric directly comparable with the fishery FTE series
Fiscal instruments (offshore wind tax EUR/MW; DPM versus EEZ allocation)	Offshore wind	6	Policy	Ministère de la Transition Écologique	Links the spatial position of an installation to the legal rule governing benefit retention

Prioritization within the retained set followed the distributive framing outlined in Section Positioning SEBA Among Socioeconomic Assessment Approaches in MSP. Employment and firm location were treated as primary indicators because they identify beneficiaries directly. Infrastructure and fiscal indicators were treated as secondary because they condition rather than constitute benefit. Financial performance indicators were treated as contextual, establishing the baseline condition of the incumbent sector rather than measuring benefit distribution as such.

2.2. Focus Area and Spatial Scale

The study operates primarily at the regional scale, aligning with the French Documents Stratégiques de Façade (DSF) planning framework, which implements the MSP Directive (2014/89/EU). The NAMO region, comprising the coastal departments of Pays de la Loire, Brittany, and Normandy, was selected for the focused application of SEBA because of the spatial overlap between offshore wind developments and traditional fishing activities.

The NAMO façade was selected on four grounds rather than convenience. First, it is the only French façade in which both sectors are simultaneously at national maximum: it accounts for 70.6% of national first-sale fishery revenue and 73.3% of landings by volume and concurrently hosts three of the four commissioned or near-commissioned commercial offshore wind farms. A comparison of benefit distributions requires a setting in which both distributions are non-trivial. Second, it contains the fullest available evidence base: Yeu–Noirmoutier is the only French project for which the operator has published a directory of local subcontractors, which makes NAMO the only façade where regional-scale findings can be checked against sub-regional data. Third, it is where the forward planning pressure is concentrated, since the BNO, BNE, and BGL zones identified in the 2023–2024 national debate all fall within or adjacent to the façade, so conclusions bear on decisions that have not yet been made. Fourth, its fisheries are dominated by small-scale, place-bound vessels,

which is the segment least able to absorb spatial displacement and therefore the one for which the distributive question is most consequential. Mediterranean façades were not selected because fishery activity there is marginal in national terms (PACA accounts for 0.96% of first-sale revenue), which would make any benefit comparison uninformative.

The regional scale was chosen over finer spatial units (e.g., two-digit postal codes) for methodological consistency (regional aggregation was necessary because 73% of fishery employment data [32] and 65% of offshore wind firm addresses (corporate registries) are reported only at the regional (NUTS-2) level; finer scales would require imputation, introducing >40% uncertainty. Regional units also align with DSF planning boundaries, enabling direct policy application) and data availability, facilitating comparative analysis across sectors, and enabling the detection of intra-national disparities, potential conflict zones, and coexistence opportunities. This scale also aligns with policy frameworks, ensuring that the findings are directly relevant to planning authorities.

The choice of the NUTS-2 regional unit carries a cost that should be stated plainly. Regional aggregation cannot resolve differences between coastal and inland communes within the same region, and it therefore cannot show whether the benefits attributed to, for example, Brittany accrue to the port towns adjacent to a wind farm or to inland engineering firms in Rennes. Because the burden of spatial displacement falls on specific harbours rather than on regions, this is a genuine mismatch between the resolution of the analysis and the resolution of the problem. Three considerations bound the consequence. First, the mismatch affects the interpretation of within-region equity but not the between-region comparison, which is the object of the study. Second, the DSF planning boundaries are themselves façade-level, so regional outputs remain directly actionable at the scale at which French plans are adopted. Third, the one dataset that does permit a finer-scale check, the Yeu–Noirmoutier subcontractor directory mapped at commune level, can be used to test whether regional conclusions survive disaggregation; that test is reported in Section 4.5. Where the two scales diverge, the finer scale is treated as authoritative, and the regional claim is qualified accordingly.

2.3. Data Sources and Collection Protocols

Given the absence of a centralized socioeconomic marine data repository in France, this study adopted a multisource, mixed-method data acquisition strategy. Data collection covered both quantitative indicators (e.g., installed capacity, employment, landings) and qualitative descriptors (e.g., firm roles, regional participation), with an explicit focus on transparency, traceability, and policy relevance. Data were cross-verified wherever possible; however, approximately 30% of firm-level entries relied on single sources (corporate websites, EIA annexes) without independent confirmation. Subcontractor lists, particularly for Yeu–Noirmoutier, are likely to underrepresent informal or short-term contractors. These gaps introduce uncertainty into firm participation maps, potentially overstating organized supply chain actors and understating small, local firms. French-language documents were translated into English using DeepL Translate to enhance accessibility.

2.3.1. Offshore Wind Sector Data

Offshore wind data collection focused on three core dimensions: spatial project footprints, industrial value chain composition, and regional economic participation. Key parameters included installed and planned capacity, project phase, technical specifications, stakeholder roles, firm-level characteristics (type, ownership, geography), and regional employment metrics.

Primary data sources included France Énergies Marines, RTE, Ministère de la Transition Écologique, WindEurope, 4C Offshore, regional port authorities, corporate reports

(e.g., EDF, Siemens Gamesa), public Environmental Impact Assessments, and industry directories. Where direct firm-level data were unavailable, we inferred missing information from credible reports, procurement records, and public consultation summaries. Data were processed in Python 3.13.2 (Cursor platform 0.49 (Anysphere, Inc.)) for cleaning and structuring and visualized using Tableau Public.

2.3.2. Fishery Sector Data

Fishery data covered both economic structure and spatial dynamics, including landings quantity and value by port, fleet size and typology, auction centre activity, employment patterns, and financial viability metrics. Primary sources comprised FranceAgriMer, IFREMER, Ministère de la Mer, CRPMEM, EMFF/EMFAF financial reports, port-specific auction data, and STECF datasets. Geolocation was based on port identifiers, auction centre coordinates, and vessel registries to assess community dependence and spatial overlaps with offshore wind zones. Structural vulnerability was contextualized using indicators such as vessel decline, shifts towards part-time operation, and reliance on subsidies.

Data acquisition followed sector-specific protocols to accommodate asymmetric reporting granularity. For offshore wind, firm-level data were compiled from corporate registries (SIRENE), Environmental Impact Assessments (Saint-Brieuc, Saint-Nazaire, Yeu-Noirmoutier), industry directories (4C Offshore, WindEurope), and operator disclosures (EDF, EMYN). Where gaps occurred (e.g., incomplete subcontractor lists for 6 of 9 offshore wind projects), we prioritized operator-issued reports and systematically flagged unverified entries (see Section 2, Data Limitations). For fisheries, fleet and economic data were sourced from FranceAgriMer (annual reports 2012–2023) [37], IFREMER (SIH database) [38], and regional fishery committees (CRPMEM).

Missing and inconsistent entries were handled under a fixed, pre-declared protocol rather than case by case. Missing values were never imputed; a firm or region for which an attribute could not be established was recorded as unknown and excluded from the denominator for that attribute, with the reduced denominator reported. Where two credible sources disagreed on a categorical attribute such as functional role, precedence was given in the order: operator- or developer-issued project documentation, then the SIRENE corporate registry, then industry directories, then press material. Where sources disagreed on a numerical value, the value from the most recent official statistical release was retained and the discrepancy recorded in the supplementary database. Duplicate entries arising from subsidiaries filed under separate SIRENE numbers were consolidated to the operating entity when the parent and subsidiary shared a single functional role and retained separately when they did not. Entries resting on a single unverified source were flagged in the database and are carried through the analysis as Tier C data (Section 2.6), so that any result driven by them can be identified.

2.4. Data Processing and Spatial Visualization

Data cleaning, structuring, and integration were conducted using Microsoft Excel and Python 3.13.2 (pandas library 3.0.5), covering SEBA steps 4 to 6 (database development, spatial mapping, and interpretation). Offshore wind data underwent project-level firm mapping, national value chain categorization, and a subcontractor-specific case study for Yeu-Noirmoutier, leveraging rare operator disclosures to analyze local content development.

Spatial visualizations were produced using Tableau Public 2023.3 (free licence) with custom NUTS-2 shapefiles. Firm addresses were geocoded via the Nominatim API (OpenStreetMap); ambiguous matches (4.7%; $n = 22$) were manually verified against corporate registries. Dashboards use two-digit postal code aggregation (median spatial resolution: 1200 km²). Interactive files and source data—enabling interactive exploration of national

firm distributions, project-specific footprints, and subcontractor networks. This open-access approach enhances transparency, reproducibility, and stakeholder engagement compared to prior SEBA implementations relying on proprietary GIS software.

The fishery sector outputs similarly employed Tableau to visualize auction centre distributions, fleet changes, employment shifts, and financial stress markers, producing spatially explicit indicators of socioeconomic vulnerability relative to offshore wind developments.

Spatial outputs were validated in four ways. First, geocoding was verified by reverse lookup: each geocoded coordinate was mapped back to a NUTS-2 region and compared with the region declared in the source record, and the 4.7% of cases ($n = 22$) that disagreed were resolved manually against corporate registry entries. Second, regional firm totals were cross-checked against the independently compiled France Énergies Marines and regional cluster directories; the ranking of regions was identical, and absolute counts agreed within approximately 10% for the five leading regions. Third, the regional employment layer, which derives from the Observatoire des énergies de la mer, was compared with the firm-count layer, which derives from corporate registries; because these are independent sources measuring related quantities, their divergence is itself informative and is reported as a substantive finding in Section 3.3 rather than treated as error. Fourth, fishery auction-centre locations and landings attributions were checked against port identifiers in the FranceAgriMer series, with full agreement. No ground-truthing through site visits or stakeholder verification was possible; this residual and important limitation is discussed in Section 4.5.

2.5. Mixed-Method Justification

The integration of quantitative spatial economic mapping with qualitative interpretation of sectoral dynamics addresses the limitations of conventional economic assessments that lack spatial resolution and stakeholder specificity. The dual-scale application of SEBA (project-specific and regional) accommodates fragmented and unevenly reported economic data, enabling multi-layered analysis of participation, value distribution, and conflict potential. This mixed-methods design addresses three limitations of prior SEBA applications [13]: (1) single-sector focus (we compare offshore wind vs. fisheries), (2) static GIS outputs (we enable dynamic filtering via Tableau Public), and (3) national-only scales (we nest project-level firm mapping within regional analyses). Quantitative spatial mapping reveals where benefits concentrate;

Formal expert interviews were not conducted due to project timeline constraints. This limits validation of interpretive claims (e.g., stakeholder perceptions of spatial equity) but does not affect factual firm participation mapping, which relies on publicly verifiable registries. Future work should integrate participatory workshops to co-interpret SEBA outputs with affected communities. The study utilized a structured review of diverse secondary sources, including policy documents, corporate disclosures, and workshop proceedings which included a systematic review of 47 documents (12 EIAs, 18 corporate annual reports, 9 regional economic impact studies, 8 MSP consultation summaries).

Conflicting data (e.g., differing subcontractor counts) were resolved by prioritizing operator-issued reports; unresolved conflicts are noted in results. This approach prioritizes transparency and reproducibility but limits stakeholder validation of findings.

The SEBA framework was selected over alternatives such as input–output modelling (which lacks spatial resolution) and cumulative impact assessment (which prioritizes environmental over socioeconomic dimensions). SEBA’s strengths include spatial explicitness, multi-sector comparability, and accessibility to non-technical stakeholders. However, it provides static snapshots rather than dynamic projections, which is a limitation addressed in the discussion.

2.6. Uncertainty Assessment and Sensitivity Analysis

Every dataset used here carries uncertainty, and three sources of it are consequential enough to shape interpretation. The first is registered-address bias. A firm is located in this analysis by its registered or principal administrative address, which is not necessarily where the economic activity attributed to it takes place. A turbine assembly subsidiary registered in Paris but operating from Saint-Nazaire will be counted in Île-de-France, and a consultancy registered in Brest but delivering services in Normandy will be counted in Brittany. This displaces benefit towards administrative centres and away from operational sites, and it is the single most important qualification on the firm location maps. Rather than attempting a correction that the data cannot support, the analysis addresses this directly by reading the firm layer against the independently sourced employment layer: the divergence between the two is precisely the signature of registered-address effects, and it is reported as a result (Section 3.3) rather than suppressed as noise. The second source is disclosure asymmetry. Subcontractor information is complete for one of nine projects and partial or absent for the rest, which systematically understates small and locally embedded firms relative to prime contractors and therefore biases the analysis against, not in favour of, the local benefit interpretation. The third is temporal misalignment: fishery employment is reported to 2022, landings to 2023, and offshore wind employment to 2024, so cross-sector comparisons of levels are approximate and only comparisons of distribution and trend are treated as robust. Other factors, such as firm size, company structure, and differences in data coverage, may also contribute to the observed pattern.

To make these effects tractable, every data point was assigned to one of three confidence tiers (Table 3), and all concentration statistics were recomputed excluding Tier C data. Two sensitivity tests were then run. The first re-assigned the 47 firms active in multiple value chain roles under the most adverse plausible scenario, transferring all of them from the largest region to the smallest; the Herfindahl–Hirschman index moved from 0.196 to 0.176 and the Gini coefficient from 0.491 to 0.428, and the identity and order of the three leading regions were unchanged. The second withheld each data source in turn and recomputed regional shares; no single source withdrawal altered the rank order of the top three regions in either sector. The concentration and co-location findings reported in Section 3.3 are therefore robust to the data limitations identified, whereas absolute firm counts are not, and are reported throughout as shares rather than as totals.

Table 3. Data confidence tiers applied to all indicators, with the interpretive weight attached to each tier.

Tier	Definition	Indicators Assigned	Approximate Share	Permitted Interpretation
A—high	Official statistics published by a national agency on a documented, repeated methodology	Landings volume and value; fishery employment; fleet structure; GVA and profit; regional offshore wind FTE; capacity and tender status	Approximately 60% of data points	Point estimates usable; trends interpretable
B—moderate	Corporate registry or operator disclosure, cross-verified against at least one independent source	Firm identity, region, and functional role for firms appearing in project documentation and SIRENE	Approximately 25%	Usable for ranking and share analysis; absolute counts carry an estimated $\pm 10\%$ error

Table 3. Cont.

Tier	Definition	Indicators Assigned	Approximate Share	Permitted Interpretation
C—low	Single, uncorroborated source (corporate website, EIA annex, press release)	Roles and locations of minor suppliers; portions of subcontractor lists	Approximately 15%	Usable only for presence/absence; excluded from concentration statistics where it would alter the leading three regions

2.7. Quantitative Comparison of Spatial Concentration and Co-Location

Because visualization alone cannot establish whether two distributions differ, four quantitative measures were computed on the regional data underlying the maps. Spatial concentration was measured with the Herfindahl–Hirschman index, the Gini coefficient, and the three-region concentration ratio, computed on regional shares of fishery landings, fishery first-sale revenue, offshore wind firm counts and offshore wind full-time equivalents. These three statistics were used together because they are sensitive to different features of a distribution: the Herfindahl–Hirschman index responds to the presence of dominant units, the Gini coefficient to inequality across the whole distribution including regions with negligible participation, and the concentration ratio to the weight of the leading cluster. Sectoral specialization was measured with a ratio of shares, dividing each region’s share of national offshore wind employment by its share of national fishery revenue, so that values above unity identify wind-oriented regions and values below unity fishery-oriented ones. Co-location was tested with Spearman rank correlation between fishery revenue and each offshore wind variable across the regions present in both datasets. Finally, benefit intensity was expressed as full-time equivalents per mapped firm, which isolates the divergence between corporate presence and employment described in Section 2.6.

Two constraints on inference follow from the data structure and are respected throughout. The number of spatial units is small, between five and eleven depending on the variable pair, so rank correlations are reported with their exact sample size and *p*-value and are not used to support claims of statistical generality. Parametric tests of difference between sectors were not performed, because the regional observations are neither independent nor drawn from a sampling frame; they constitute the population of French coastal regions. The statistics are therefore used descriptively, to characterize and compare two known distributions, and not inferentially.

2.8. Causal Interpretation, Environmental Scope and Transferability

The design of this study supports statements about association and co-location and does not support statements about causation. Where offshore wind development and fishery vulnerability are found in the same regions, this reflects a shared dependence on productive, accessible continental-shelf waters and on established port infrastructure. It does not demonstrate that offshore wind development has caused fishery decline. The contraction documented here predates commercial offshore wind deployment in France: the fleet fell by 29% between 2000 and 2023 and employment by 9.5% between 2012 and 2022, whereas the first commercial farm was commissioned only in 2022. The appropriate formulation, used consistently in the Results and Discussion, is that offshore wind constitutes an additional spatial pressure on a sector whose vulnerability has other and longer-standing origins, including quota regimes, fuel costs, generational renewal, and market structure. Establishing causal effect would require vessel-level effort data before and after construction, ideally with a matched control area, which is beyond the scope of a benefit-mapping exercise and is identified in Section 4.5 as a priority for further work.

The framework as applied here does not consider environmental impacts. It quantifies neither the ecological consequences of turbine installation nor the carbon abatement that offsets them, and it assigns no value to habitat, biodiversity, or ecosystem services. This is a scope decision, not an oversight: SEBA is a distributive instrument, and loading ecological variables into it would compromise the comparability that gives it its analytical purchase. The practical implication is that SEBA outputs are one input among several and cannot on their own justify a zoning decision. Section 4.5 examines how environmental indicators could be articulated with, rather than absorbed into, the framework, and how doing so would be likely to affect the conclusions.

The methodology is transferable under three conditions: a public corporate registry that records principal activity and address, published landings or equivalent production statistics at a consistent spatial unit, and a planning framework whose boundaries correspond to that unit. These conditions are met across the European Union, where business registers and Data Collection Framework returns are harmonized, so replication in the other three French façades or in comparable jurisdictions such as Spain, Portugal or Ireland requires no methodological change. Transfer to jurisdictions with concessional or customary tenure, weak firm registration or predominantly informal fisheries would require substituting the firm as the unit of analysis, for instance with cooperative membership or landing-site dependence. Transfer across governance systems, as distinct from data systems, raises a further question addressed in Section 4.8.

3. Results

3.1. Fisheries

3.1.1. Fishery Regional Fish Landings and Revenue (2023)

The spatial distribution of fresh and frozen fish landings and their associated revenues across France in 2023 reveal pronounced regional disparities. Atlantic coastal regions overwhelmingly dominate both catch volume and economic returns (Figure 1).

Regional Distribution of Fresh and Frozen Fish Landing* and Revenue Generated in 2023**

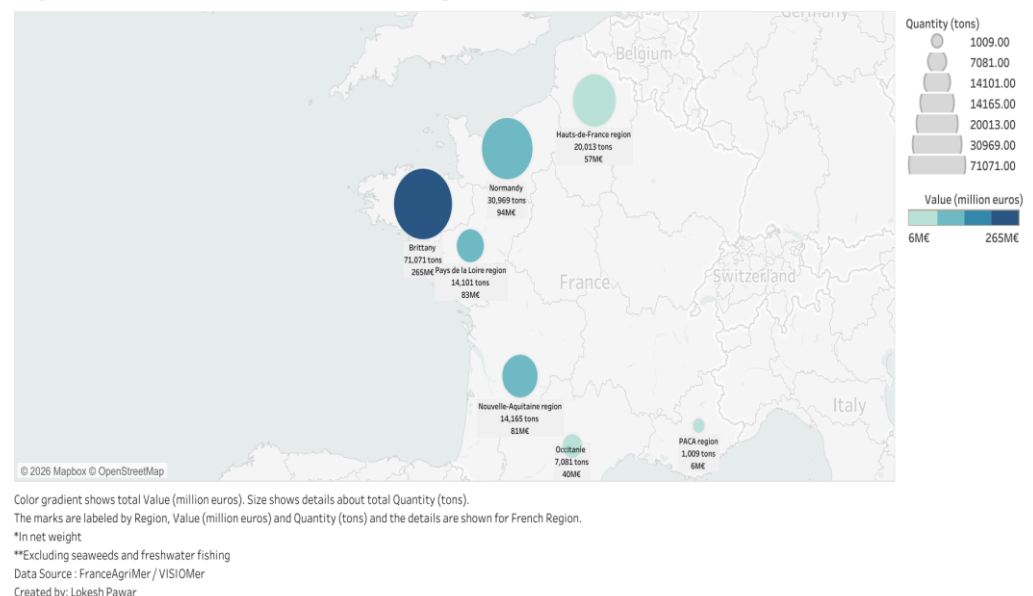


Figure 1. Regional distribution of fresh and frozen landings and revenue generated in 2023 along with French coastline.

Brittany stands out as the leading region, with approximately 71,071 tons of fish landed and generating 265 million EUR in revenue, representing the largest share nationally. This dominance reflects Brittany's longstanding significance in both industrial and artisanal

fisheries, supported by dense coastal infrastructure, including multiple auction centres and active fishing fleets, as elaborated in subsequent sections. Normandy follows with 30,969 tons landed and 94 million EUR in revenue. The Pays de la Loire and Nouvelle-Aquitaine regions recorded nearly identical landings of 14,101 and 14,165 tons, respectively, yet their revenues differ slightly (83 million and 81 million EUR), suggesting variations in species composition or market integration strategies, potentially favouring higher-value species in Pays de la Loire.

Conversely, southern regions such as Occitanie (7081 tons, 40 million EUR) and Provence–Alpes–Côte d’Azur (PACA) (1009 tons, 6 million EUR) play a marginal role in national fishery production. These lower figures are likely to result from a combination of ecological constraints, smaller fleet sizes, reduced productivity, and spatial competition from tourism and conservation efforts along the Mediterranean coastline.

The concentration of 82% of national landings in three Atlantic regions (Brittany, Normandy, Pays de la Loire; Figure 1) co-occurs with 67% of planned offshore wind capacity. This co-location, which is absent in Mediterranean regions, is a spatial association and not evidence that one sector affects the other; it indicates where region-specific trade-offs between fishery access and renewable energy zones are liable to arise, and these are trade-offs that national MSP frameworks [31] do not currently disaggregate spatially. Region-specific strategies are therefore necessary to prevent disproportionate burden-shifting onto Atlantic communities. From a SEBA perspective, these uneven spatial patterns highlight the importance of integrating ecological productivity with socioeconomic factors to design equitable spatial policies that ensure balanced regional benefits.

3.1.2. Employment Distribution (2012–2022)

Employment data for fishermen in 2022 provide critical insights into the spatial dynamics and structural transformations within the French fishery sector (Figure 2). Mainland France employed 9162 full-time equivalents (FTEs) in 2022 marking a 9.5% decline from 10,126 FTEs in 2012 (964 FTEs lost; compound annual decline rate of 1.0% (calculated as $[(9162/10,126)^{1/10} - 1] \times 100$), indicating persistent year-over-year workforce erosion rather than a one-time shock (Figure 3).

The Bay of Biscay zone accounted for the highest employment with 2978 fishermen, followed by the Celtic Sea and West of Scotland (2585), the Eastern Channel and North Sea (1807), and the Mediterranean (1792). This spatial employment distribution closely mirrors patterns observed in fish landings and revenue, reinforcing the correlation between regional production capacity and job retention.

The overall employment decline is attributable to multiple factors including ageing workforce demographics, fleet downsizing, diminished profitability, policy-driven access restrictions, and market volatility. Brittany’s status as a socioeconomic fishery hub is reaffirmed by its substantial revenue generation (265 million EUR), whereas regions such as Occitanie and PACA maintain minimal employment footprints due to lower biological productivity and fewer active ports.

Additionally, evidence points to fleet modernization, rising fuel costs, and shifts toward part-time or seasonal fishing models as contributing to the erosion of traditional full-time employment, particularly in marginal regions. Within the MSP context, these spatial employment disparities necessitate tailored socioeconomic safeguards. Regions with high dependency on fisheries, especially along the Atlantic façade, face heightened vulnerability from spatial reallocations such as offshore wind farm development or marine protected areas (MPAs). Incorporating employment data into SEBA mapping enhances MSP’s capacity to identify socioeconomically vulnerable zones, thereby facilitating balanced negotiations between industrial offshore expansion and fishery sustainability.

Regional Distribution of Fishermen’s Jobs on French Fishing Vessels in 2022

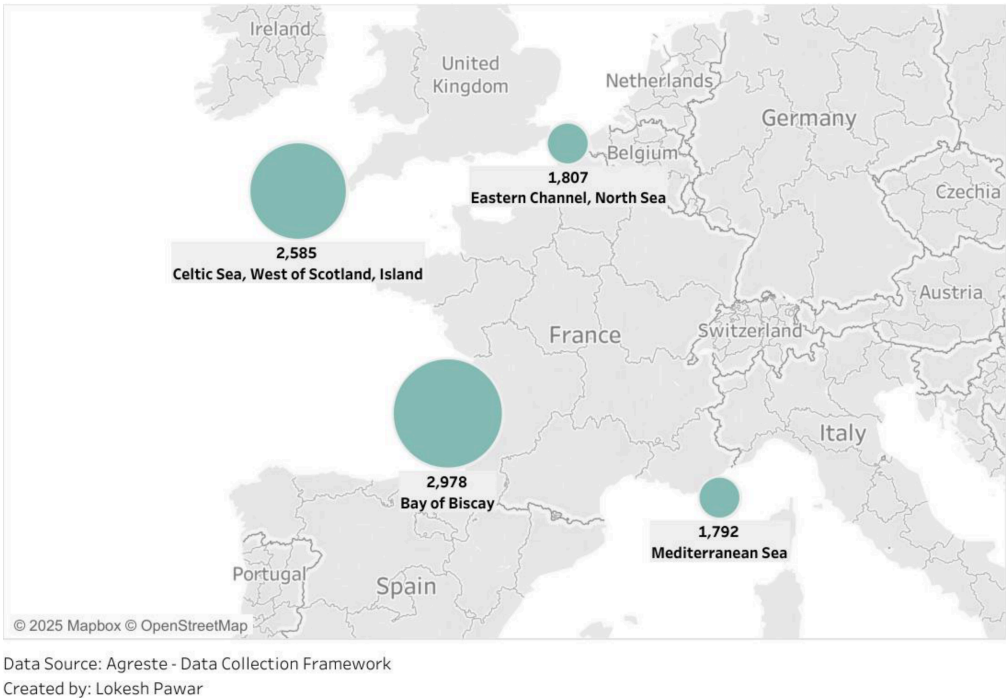
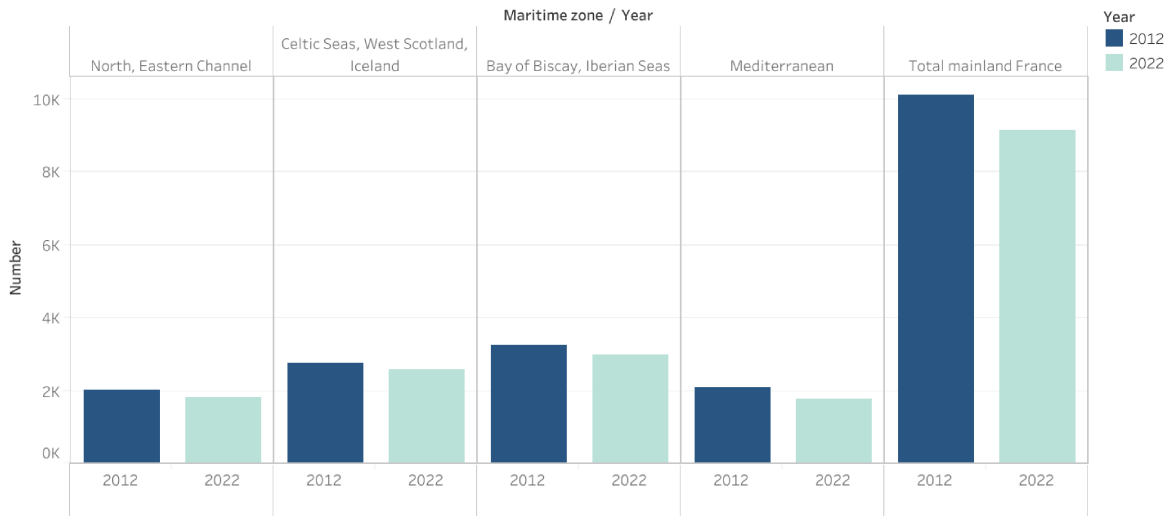


Figure 2. Regional distribution of fishermen employed in different French marine zones.

Regional Employment Trend (2012 vs 2022)



Number as an attribute for each Year broken down by Maritime zone and color shows details about Year.
Data Source: Agreste - Data Collection Framework
Created by: Lokesh Pawar

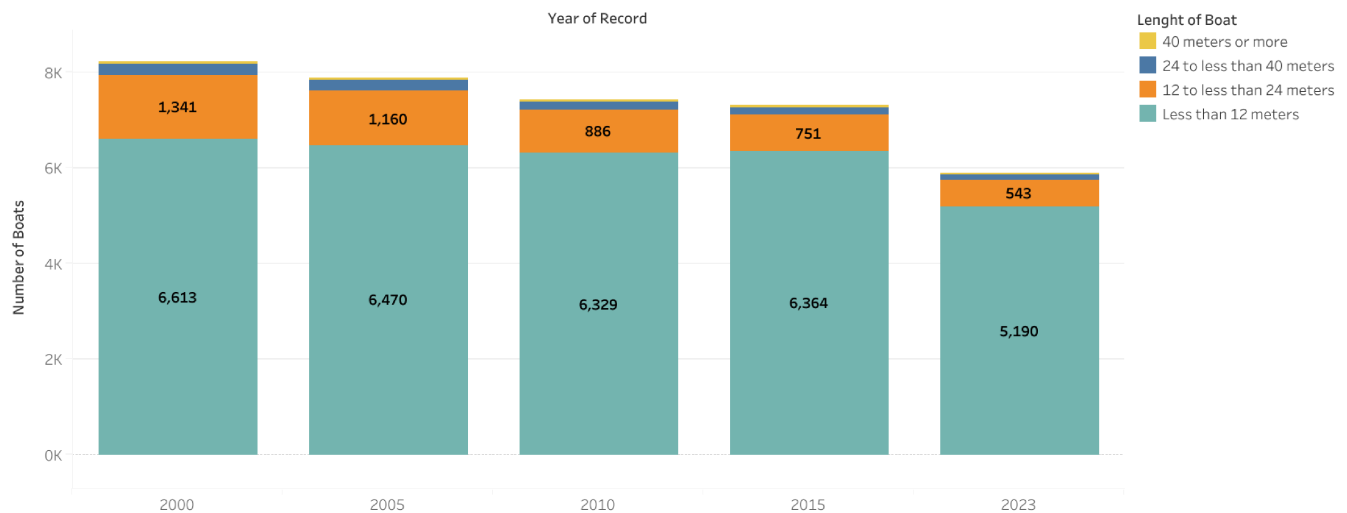
Figure 3. Region-wise temporal employment trend in capture fisheries, i.e., fishermen on French vessels (all nationalities).

3.1.3. Structural Infrastructure and Fleet Evolution (2000–2023)

Between 2000 and 2023, the French fishing sector experienced a significant contraction in both structural infrastructure and fleet size, trends with major implications for socio-economic resilience and marine spatial planning. The total number of vessels declined by approximately 29%, from 8118 in 2000 to 5734 in 2023, with the most pronounced reduction occurring in the small-scale fleet (under 12 m), which decreased from 6613 to 5190 vessels (Figure 4). This decline indicates a gradual erosion of artisanal and coastal fish-

eries, especially in less industrialized or lower-yield regions. Contributing factors include modernization incentives, ageing fleet demographics, rising operational costs (notably fuel and maintenance), and increasingly stringent regulatory frameworks such as quota reductions and access limitations. Additionally, low generational renewal and shifting market preferences have further exacerbated this trend.

Number of French Fishing Vessels (2000–2023)



Number for each Observation Year and color shows details about Category Set.
 Data Source: Agreste - Data Collection Framework
 Created by: Lokesh Pawar

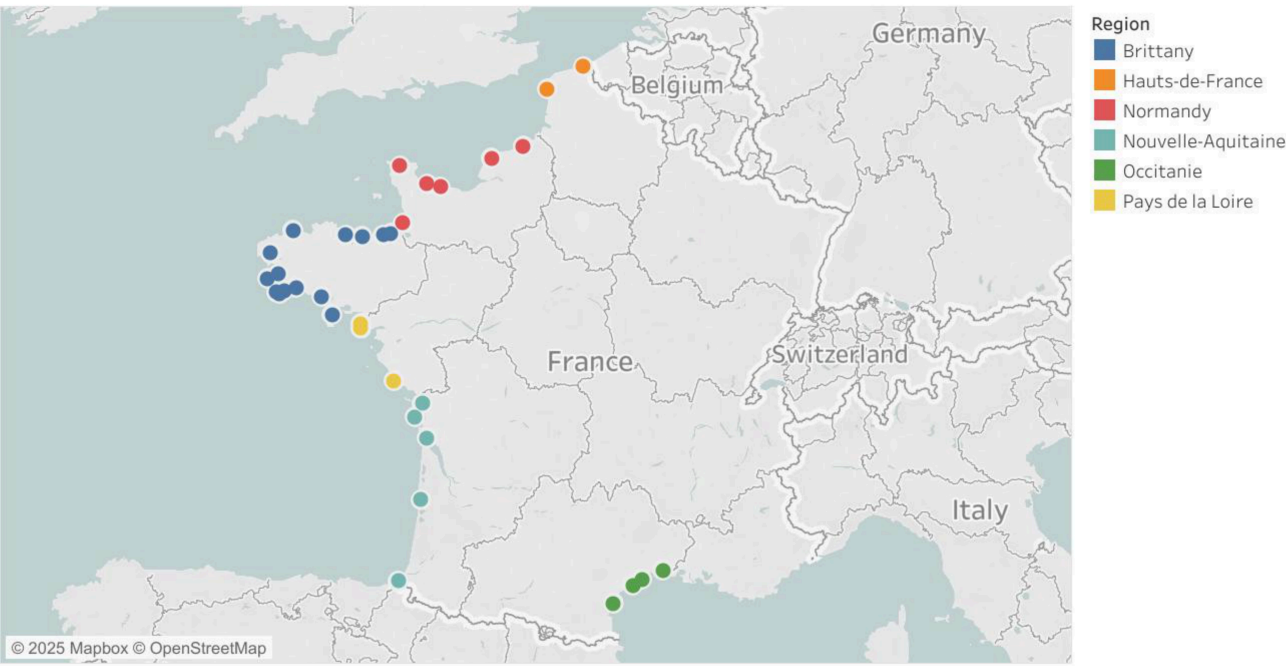
Figure 4. Temporal trend of French fishing vessels in French region.

The spatial distribution of France’s 34 active fishing auction centres (Figure 5) reveals a disproportionate concentration in Atlantic regions, predominantly Brittany and Normandy, while the Mediterranean and southern Atlantic coasts exhibit limited infrastructure density. These patterns bear significant relevance for spatial demand dynamics: concentrated activity in fewer regions may intensify localized spatial pressures on marine ecosystems, while simultaneously releasing capacity in other areas. Consequently, marine spatial planners must integrate fleet and infrastructure trajectories into decision-making processes to ensure equitable benefit distribution and sustainable regional development, particularly as offshore wind energy expansion intensifies spatial competition.

3.1.4. Economic Performance and Financial Dependency (2016–2022)

The economic performance of the French mainland fishing fleet, evaluated through Gross Value Added (GVA), Gross Margin, and Net Profit, reveals a decline in financial viability despite sustained production levels. Between 2016 and 2018, GVA remained relatively stable at over 850 million EUR, with net profits peaking above 140 million EUR in 2017. However, from 2019 onwards, net profits consistently turned negative, enduring persistent losses through 2022, while GVA fluctuated between 700 million and 800 million EUR (Figure 6). Notably, net profit figures exclude direct income subsidies, implying that actual financial losses may be more severe without public support. These data indicate that although fishing operations continue to generate market revenues (reflected in positive gross margins), the sector fails to cover total costs when accounting for depreciation, capital opportunity costs, and other fixed expenditures.

34 Fishing Auction Centres in France



Color shows details about Region.
Data Source : FranceAgriMer / VISIOMer
Created by: Lokesh Pawar

Figure 5. Regional distribution of French auction centres.

Gross Value Added, Margin and Net Profit from Fisheries (2016-2022)



Net profit is the difference between revenue (excluding direct income subsidies) and all costs, including depreciation and the opportunity cost of capital, conventionally estimated by applying an interest rate of 3.5% to the capital value.
Scope: France excluding Mayotte and excluding less than 12 meters for Réunion.
Data Source: Agreste - Data Collection Framework
Created by: Lokesh Pawar

Figure 6. Economic performance of mainland French fishing fleet.

This structural unprofitability renders the sector heavily reliant on state and European Union financial support mechanisms, such as the European Maritime and Fisheries Fund (EMFF). The sector’s dependence on subsidies underscores its economic fragility, suggesting that many fishing enterprises, particularly small- and medium-scale operators, would

become economically non-viable without ongoing public funding [39]. From a marine spatial planning standpoint, this financial dependency raises critical concerns regarding long-term sustainability and resilience. Spatial policies that restrict access to productive fishing areas whether through environmental zoning, offshore infrastructure development, or conservation measures must carefully consider the sector’s fragile economic baseline. Accordingly, SEBA frameworks should incorporate economic vulnerability assessments to identify regions and fleets most at risk under potential subsidy restructuring or withdrawal, thereby informing more balanced and sustainable spatial governance.

3.2. Offshore Wind Sector Development and Regional Industrial Integration in France

3.2.1. National Offshore Wind Development Trajectory and Energy Transition Targets

The development of offshore wind farms within France’s Exclusive Economic Zone (EEZ) reflects a strategic alignment with the country’s broader energy transition objectives. Figure 7 provides a comprehensive overview of all offshore wind projects, categorized by their stages of development from public debate and tendering phases to operational status—while distinguishing fixed-bottom and floating technologies and illustrating regional disparities in project maturity. Figure 8 provides additional details.

Overview of all the French Offshore Wind Farm Projects

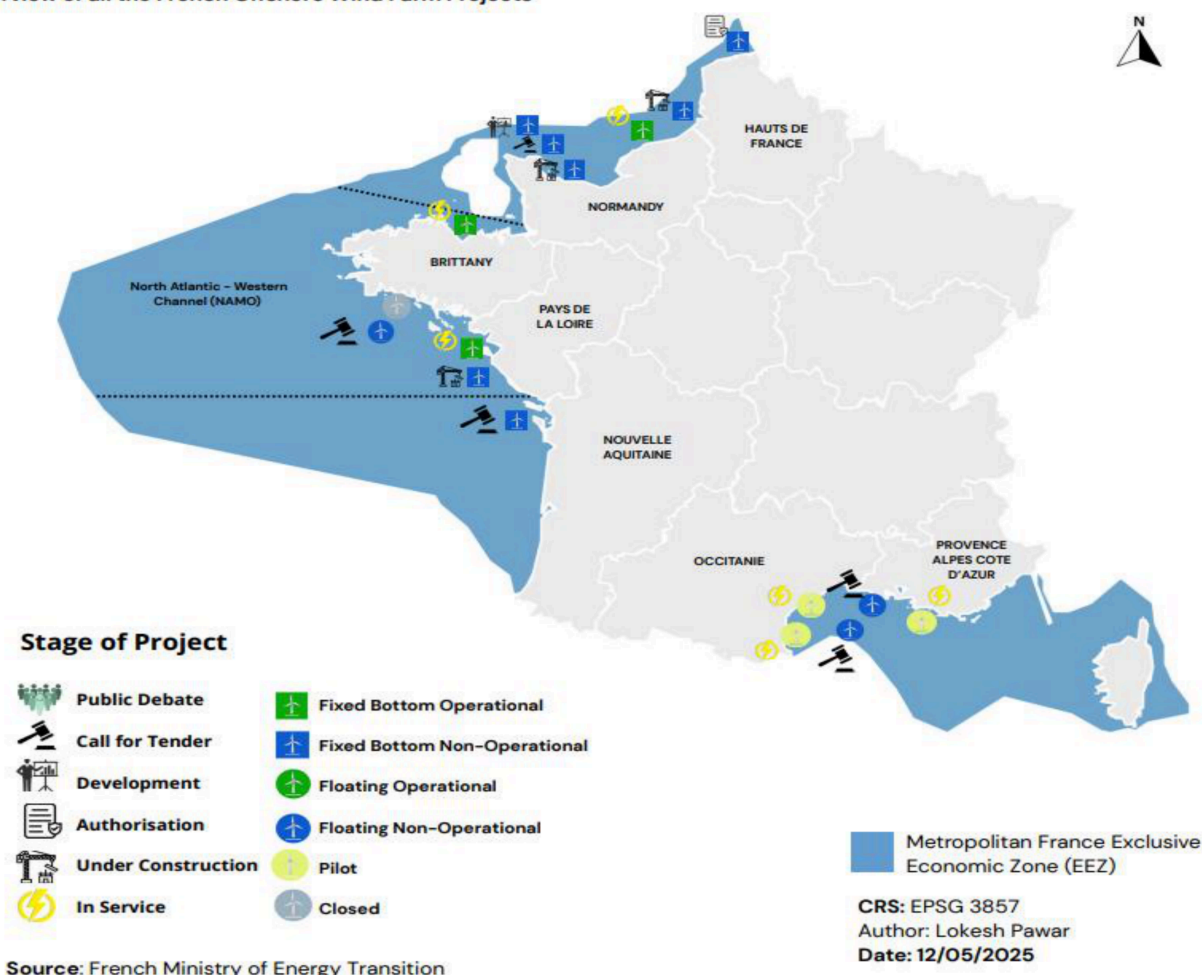


Figure 7. The illustration presents a comprehensive overview of all offshore wind farm projects within France’s Exclusive Economic Zone (EEZ), classified by their current stage of development ranging from public debate and tendering to operational status. It distinguishes between fixed-bottom and floating technologies, highlighting regional variation in project maturity across coastal zones.

French Progress in Deploying Offshore Wind Farms

Wind Farm / Zone	Capacity (MW)	Tender Round	Technology	Distance to Shore	Status / Commissioning									
					Complete 2022	Complete 2024	In build 2025	Planned 2025	Planned 2028	Finalists selected	Planned TBD	Planned 2031	Planned 2032	Planned 2032–34
Courseulles-sur-Mer	448	AO1 (2012)	Fixed-bottom	11 km										
Fécamp	498	AO1 (2012)	Fixed-bottom	13 km										
Saint-Brieuc	496	AO1 (2012)	Fixed-bottom	16.3 km										
Saint-Nazaire	480	AO1 (2012)	Fixed-bottom	12 km										
Dieppe Le Tréport	496	AO2 (2014)	Fixed-bottom	15.5 km										
Îles d'Yeu & Noirmoutier	496	AO2 (2014)	Fixed-bottom	11.7 km										
Dunkerque	600	AO3 (2019)	Fixed-bottom	11.4 km										
Centre Manche 1	1,050	AO4 (2023)	Fixed-bottom	>32 km										
Pennavel (Bretagne Sud)	250	AO5 (2024)	Floating	TBD										
Golfe du Lion 1 (Leucate/Faraman)	250	AO6 (2022)	Floating	TBD										
Golfe du Lion 2 (Fos-sur-Mer)	250	AO6 (2022)	Floating	TBD										
Sud-Atlantique I	1,050	AO7 (2024)	Fixed-bottom	>35 km										
Centre Manche 2	1,400–1,600	AO8 (2024)	Fixed-bottom	40–50 km										
Bretagne Sud 2	400–550	AO9 (2025)	Floating	TBD										
Golfe de Fos 2	450–550	AO9 (2025)	Floating	TBD										

The view is broken down by Status / Commissioning vs. Wind Farm / Zone, Capacity (MW), Tender Round, Technology and Distance to Shore.

Created by Lokesh Pawar

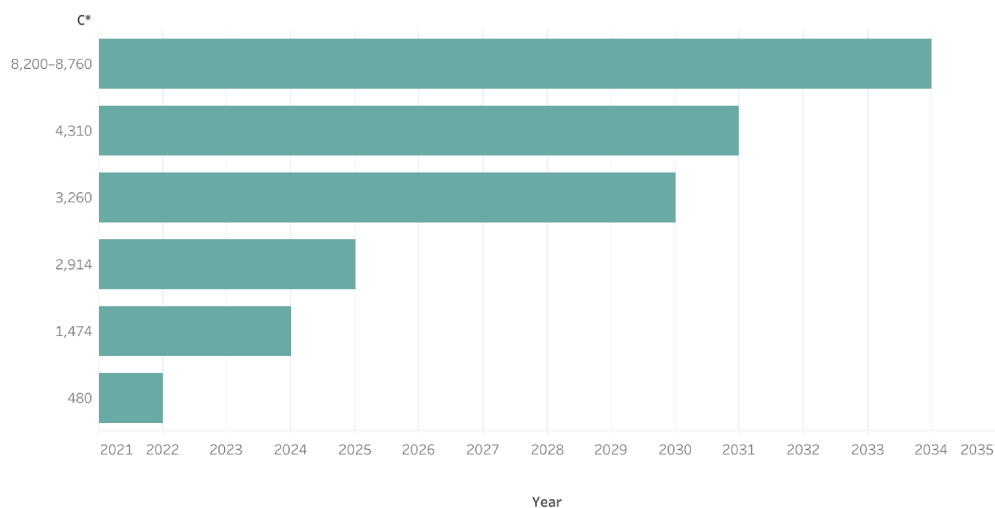
Date: May 2025

Figure 8. French progress in deploying offshore wind farms.

Energy Capacity Targets: Cumulative but Clustered Progress

Analysis of cumulative energy capacity targets, derived from practical tendering timelines (Figure 9), reveals an accelerated yet uneven trajectory in offshore wind deployment. By the end of 2022, operational capacity was limited to 480 MW, despite initial tender rounds commencing in 2011. This slow start is attributable to permitting delays, regulatory complexities, and early technological dependence on external suppliers.

Energy Targets Based on Practical Tendering



*Achievable Cumulative Capacity (MW) for different years.
Created by Lokesh Pawar

Figure 9. Achievable offshore wind energy targets in France (MW/year).

Projections indicate a sharp increase in capacity additions post-2024, with forecasted cumulative capacities of 1474 MW by 2024, 2914 MW by 2025, 3260 MW by 2030, 4310 MW by 2031, and reaching between 8200 and 8760 MW by 2034. This accelerated trajectory underscores intensified governmental commitment and improved tendering processes, driven by policy imperatives to meet decarbonization targets. However, these projections are contingent upon timely construction, maturation of local value chains, supply chain stability, and grid interconnection capacity—factors susceptible to geopolitical and economic disruptions.

Deployment Status of Offshore Wind Farms: Spatial and Temporal Delays

Despite early tender issuance dating back to 2011–2012 for projects such as Saint-Brieuc, Saint-Nazaire, and Fécamp, operationalization has experienced significant delays. For instance, the Saint-Nazaire project only achieved commissioning in 2022. Current operational capacity between 2022 and 2024 is concentrated in a limited number of sites: Saint-Nazaire (2022), Fécamp (2024), and Saint-Brieuc (2024), with Courseulles-sur-Mer expected by late 2025. Mid-term commissioning (2025–2028) encompasses Dunkerque, Dieppe–Le Tréport, and Îles d’Yeu and Noirmoutier.

Post-2030 deployments primarily involve floating wind farms (e.g., Golfe du Lion, Bretagne Sud), which remain in pilot or pre-commercial stages. These findings highlight a structural lag between tendering and deployment, particularly for fixed-bottom technology, while floating wind projects face additional delays due to technological complexity and infrastructure demands, raising concerns about their contribution toward the 2035 national targets.

3.2.2. National Composition of Firms Involved in Major French Offshore Wind Farms: Out-Sourcing Versus Domestic Dominance in the Value Chain

To evaluate industrial sovereignty and value retention, firm participation across three major offshore wind projects—Saint-Brieuc, Saint-Nazaire, and Yeu–Noirmoutier—was analyzed by country of origin, revealing varying degrees of domestic anchoring and international outsourcing.

Saint-Brieuc Wind Farm: Balanced Leadership with International Anchoring

The Saint-Brieuc offshore wind farm (496 MW) exemplifies a hybrid industrial model characterized by collaborative yet externally weighted supply chains (Figure 10). Ailes Marines, a subsidiary of the Spanish firm Iberdrola, serves as the project owner. Key international contributors include Siemens Gamesa Renewable Energy (Spain) supplying turbines; Atkins (UK) and LICEngineering A/S (Denmark) providing foundation design; BAUER Renewables Ltd. (UK) and Nervión Industries (Spain) managing foundations and piling; Prysmian (Italy) and Nexans (France) delivering subsea cables; Hitachi Energy (Switzerland) and GE Grid Solutions (France) supplying substation electrical infrastructure; and Van Oord (Netherlands) conducting marine operations. French entities such as RTE handle grid connection, while IFREMER and IN VIVO Environment undertake environmental impact assessments.

The project also engages a broad network of European consultants and port authorities, illustrating the Europeanized nature of offshore wind supply chains. While France contributes significantly to coordination, ports, grid infrastructure, and environmental expertise, high-value components (turbines, foundations, installation vessels) are predominantly sourced internationally. This configuration raises policy concerns about domestic value capture, since the share of a renewable energy value chain retained domestically is a principal determinant of the long-term regional multiplier [40,41]. The mapping shows that at Saint-Brieuc the turbines, foundations, installation vessels, and subsea cables were sourced predominantly outside France, while French firms concentrated in grid connection, port services, and environmental assessment (Figure 10). The magnitude of the resulting value leakage cannot be established from firm counts alone; quantifying it would require input–output modelling with contract-value data that are not publicly disclosed, and is identified here as a priority for further work.

Distribution of National Firms Involved in Saint Brieuc Wind Farm

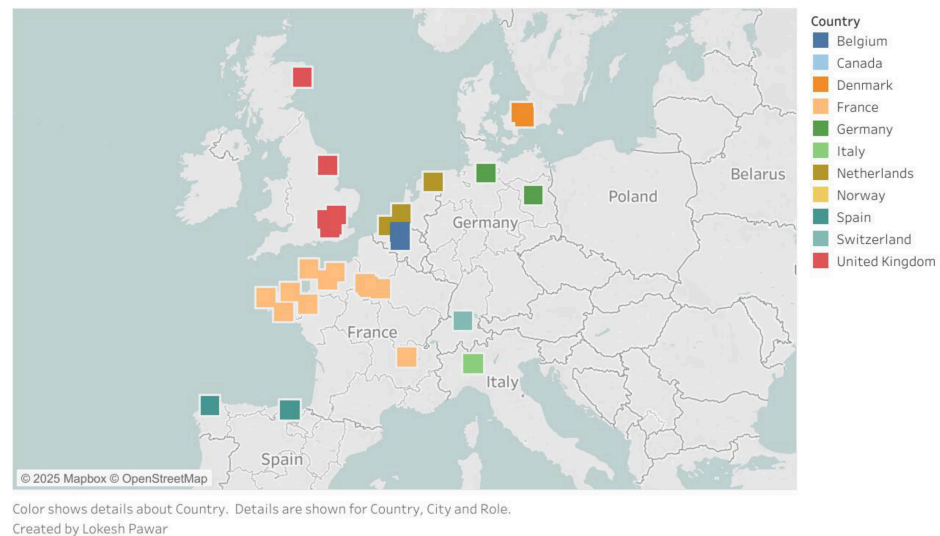


Figure 10. Geographical distribution of the firms involved in planning, constructing, and maintaining the French offshore wind farm Saint-Brieuc (Note: Canada was excluded from the map visualization to maintain appropriate geographic scale and focus on European firm distribution. The involvement of Canadian firms is still acknowledged in the data analysis).

Saint-Nazaire Wind Farm: National Anchoring with Strategic International Collaborations

The Saint-Nazaire offshore wind farm (480 MW), France's first commissioned offshore project, demonstrates strong French industrial anchoring combined with strategic international partnerships (Figure 11). The project owner, Eolien Maritime France (a joint venture of EDF Renewables and EIH SARL), is headquartered in Île-de-France, reflecting state-aligned leadership. French firms contribute notably through RTE (electricity transmission), Eiffage Métal (monopile foundations), SPIE and SPIE Grid Services (substation maintenance and turbine testing), and various port authorities and operational bases.

Distribution of National Firms Involved in Saint Naizare Wind Farm

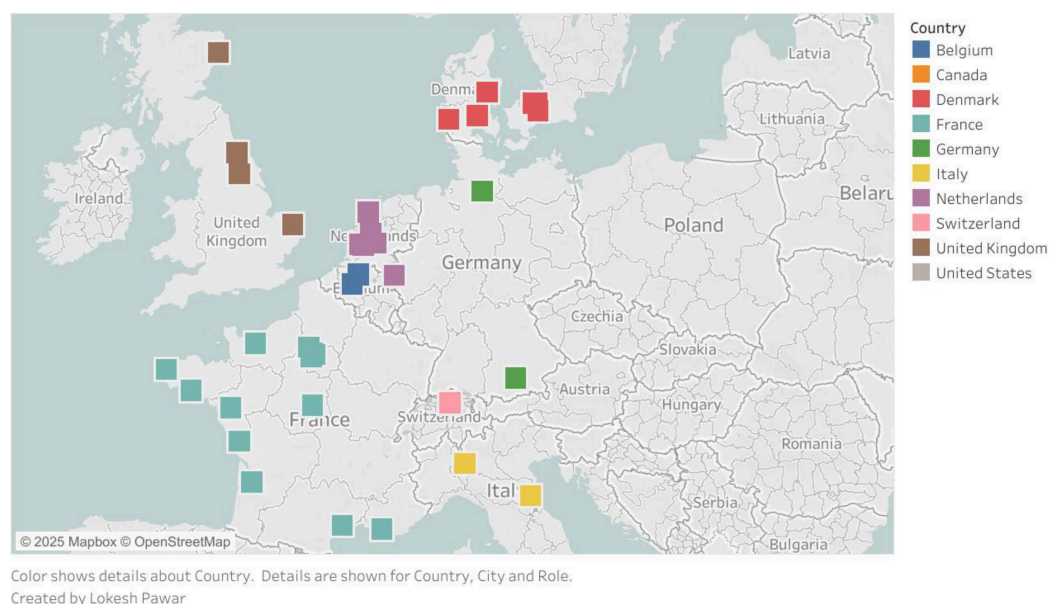


Figure 11. Geographical distribution of the firms involved in planning, constructing, and maintaining the French offshore wind farm Saint-Nazaire (Note: Canada and USA were excluded from the map visualization to maintain appropriate geographic scale and focus on European firm distribution. The involvement of Canadian firms is still acknowledged in the data analysis).

Complementing this domestic base, international firms such as General Electric Renewable Energy (France/US), Enbridge Inc. (Canada), Global Wind Service (Denmark), DEME Offshore (Belgium), Hitachi Energy (Switzerland), and Prysmian Group (Italy) provide specialized manufacturing, installation, and environmental services. The Pays de la Loire region anchors manufacturing and O&M activities, while advanced offshore engineering and cable systems are sourced from the Netherlands, Denmark, Germany, and the UK. This semi-sovereign industrial configuration illustrates France's evolving capacity to lead offshore wind infrastructure, albeit with continued reliance on international expertise for high-value components.

Yeu and Noirmoutier Wind Farm: Complex European Integration with Scattered Domestic Anchoring

The Yeu and Noirmoutier offshore wind farm (496 MW), led by EMYN and headquartered in Nantes, epitomizes complex European integration with fragmented domestic industrial participation (Figure 12). French firms such as RTE (design and operation of submarine and land cables), Artelia (electrical connection management), Sodraco International SAS (turbine installation), Atlantique Offshore Energy (substation manufacturing), and several port authorities contribute to project execution.

Distribution of National Firms Involved in Yeu Noirmoutier Wind Farm

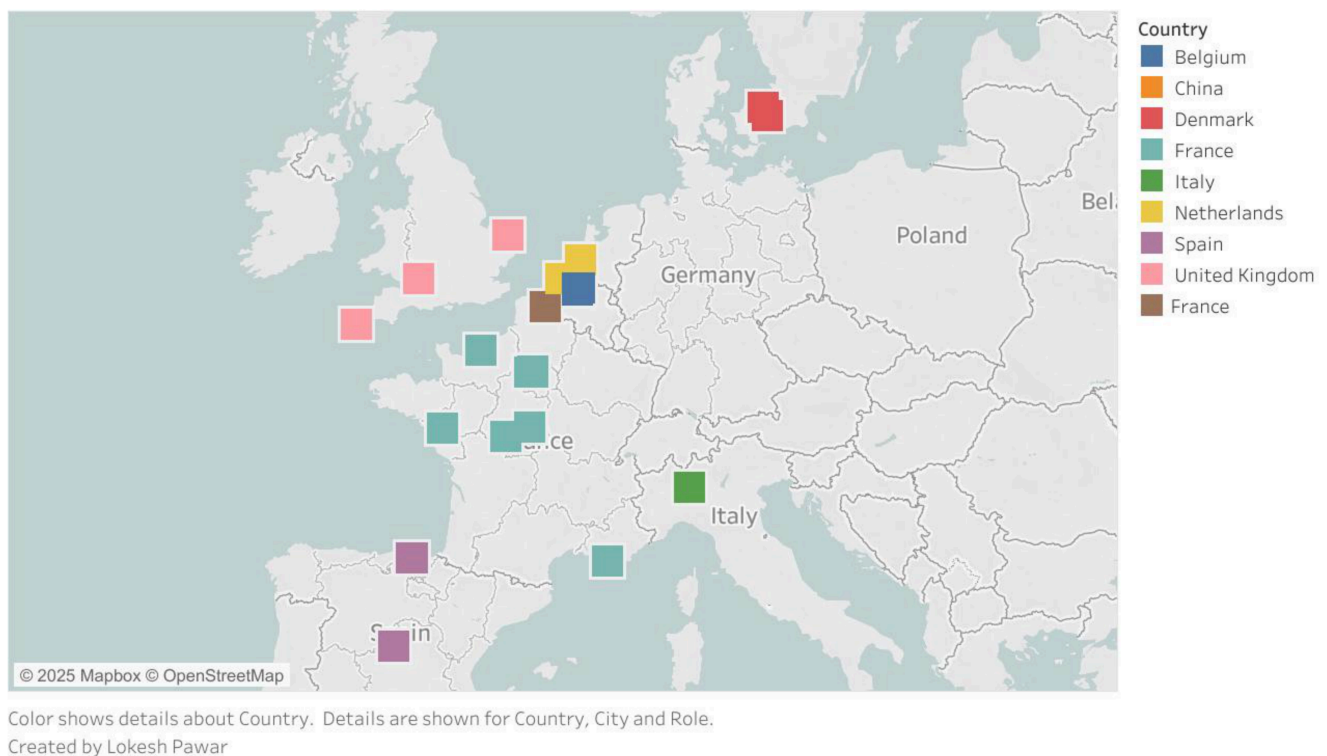


Figure 12. Geographical distribution of the firms involved in planning, constructing, and maintaining the French offshore wind farm Yeu and Noirmoutier. (Note: China was excluded from the map visualization to maintain appropriate geographic scale and focus on European firm distribution. The involvement of Canadian firms is still acknowledged in the data analysis).

However, core manufacturing and engineering tasks—particularly turbines, foundations, and substation systems—are heavily internationalized. Key foreign suppliers include Siemens Gamesa Renewable Energy (Spain), Prysmian Group (Italy), Haizea Wind Group (Spain), DEME NV (Belgium), and Dajin Heavy Industry Corporation (China). The involvement of non-EU actors, notably from China, introduces strategic considerations regarding industrial autonomy and supply chain dependencies. While local subcontracting

efforts have been made, including over 140 contracts with regional firms as documented in a directory showcasing approximately 100 local companies (Figure 13), high-value manufacturing and engineering remain largely foreign-led. This dynamic poses challenges for France's long-term industrial competitiveness and domestic innovation in offshore wind.

Local Firms Involved in Yeu Noirmoutier Wind Farms

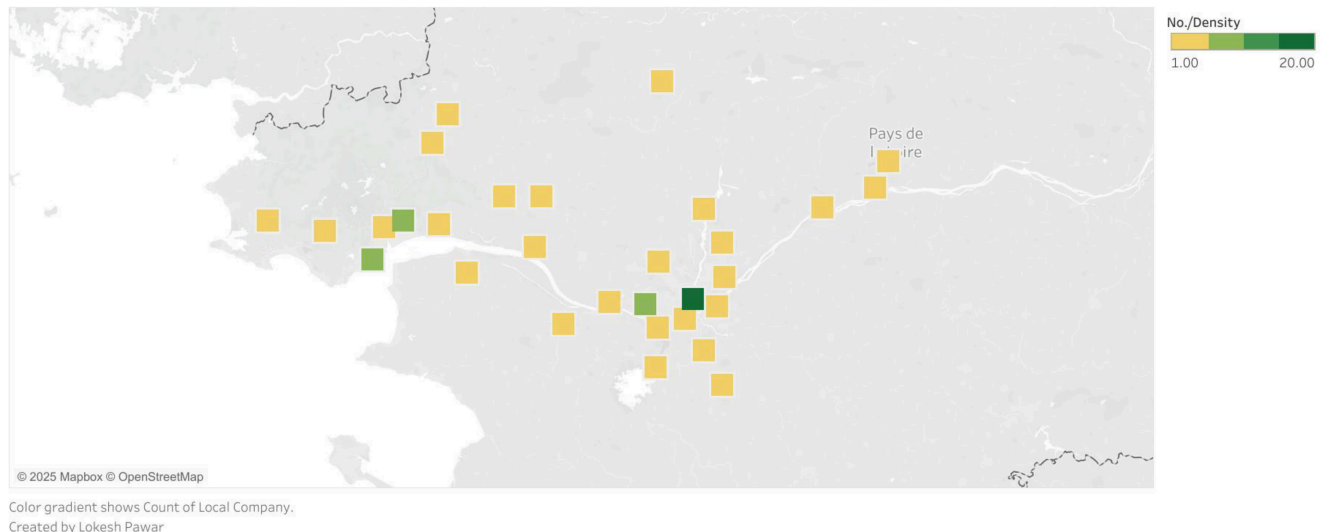


Figure 13. Local Firms involved in Yeu and Noirmoutier wind farm in Pays de la Loire.

3.2.3. Regional Participation of Local Firms in the Offshore Wind Industry: A Sectoral Ecosystem Perspective

A spatially resolved inventory of local firms involved in offshore wind development reveals differentiated regional engagement across project development, manufacturing, logistics, consulting, education, and institutional support (Figures 14–16).

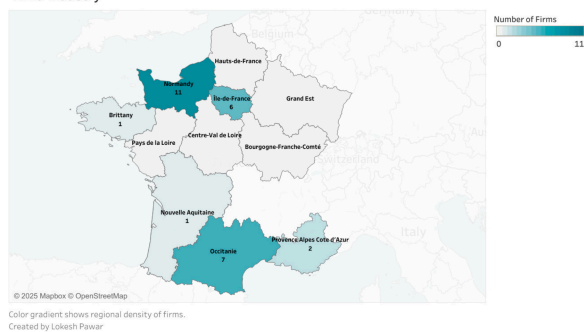
Dominant Hubs: Brittany, Pays De La Loire, and Occitanie

Brittany and Pays de la Loire emerge as principal hubs with substantial industrial capability and technical specialization. Each region hosts 77 technical and environmental consultancy firms and 71 Original Equipment Manufacturer (OEM) firms, alongside strong participation in operations and maintenance (O&M), component supply, and tertiary services (e.g., 19 firms in Brittany). Brittany and Pays de la Loire collectively account for 261 and 222 firms, respectively, making them the most engaged regions nationally. Occitanie ranks fourth with 166 firms, particularly strong in research, education, training, and technical consultancy, indicating a mature offshore wind economy with a focus on knowledge-based services and logistics.

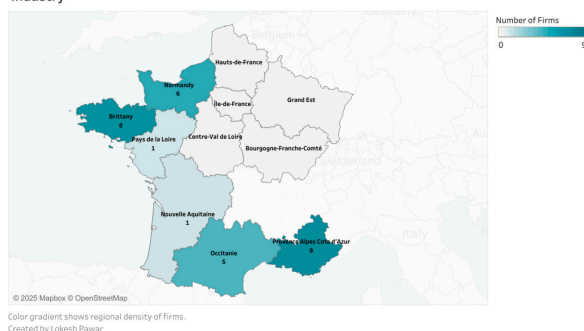
Role-Specific Regional Specialization

Role-specific clusters are evident: Normandy specializes in project development, marine and logistics services, institutional actors, and tertiary services, reflecting its proximity to major offshore zones and regulatory functions. Île-de-France, despite being landlocked, exhibits significant activity in component manufacturing and project development, likely due to corporate headquarters, engineering design, and finance roles. Provence–Alpes–Côte d’Azur (PACA) demonstrates diversified industrial activity across component manufacturing, EPC contracting, and O&M, indicative of a transition from conventional maritime sectors to renewables.

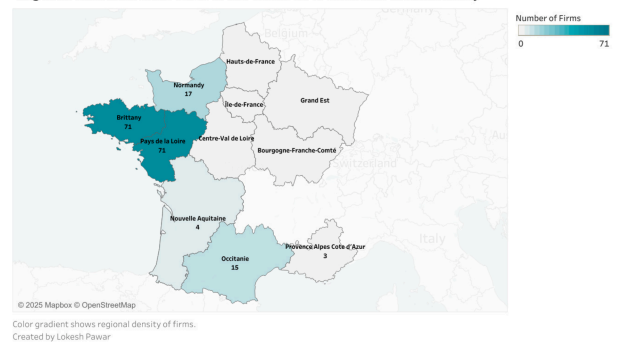
Regional Distribution of Local Project Developers Involved in Offshore Wind Industry



Regional Distribution of Local EPC Contractors Involved in Offshore Wind Industry



Regional Distribution of Local OEMs Involved in Offshore Wind Industry



Regional Distribution of Local Component Manufacturers & Suppliers Involved in Offshore Wind Industry

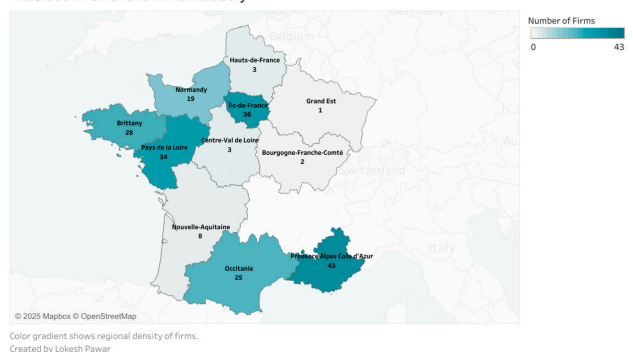
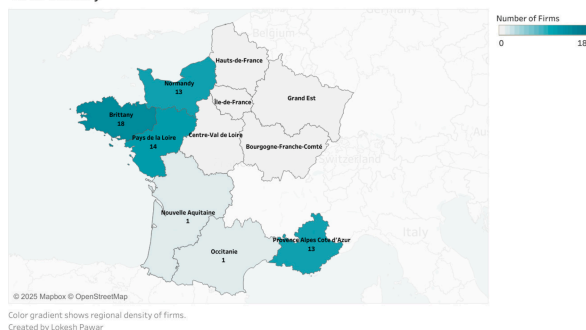
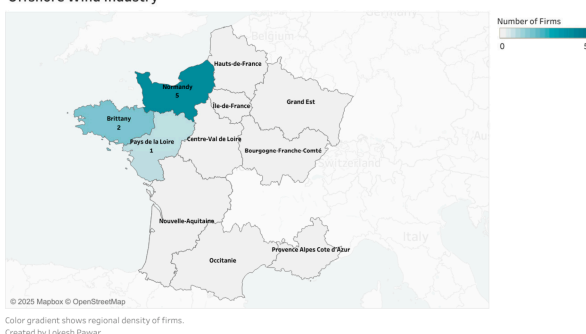


Figure 14. Regional distribution of local firms by functional role in the French offshore wind industry: project developers, original equipment manufacturers (OEMs), EPC contractors, and component manufacturers & suppliers.

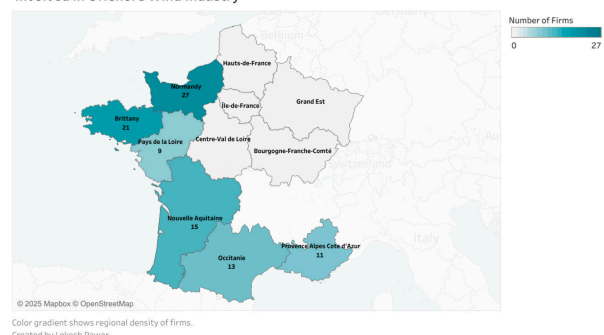
Regional Distribution of Local O&M Service Providers Involved in Offshore Wind Industry



Regional Distribution of Local Financial Institutions & Investors Involved in Offshore Wind Industry



Regional Distribution of Local Marine & Logistics Service Providers Involved in Offshore Wind Industry



Regional Distribution of Local Technical & Environmental Consultants Involved in Offshore Wind Industry

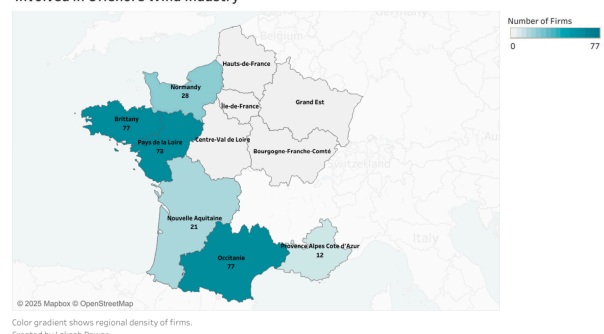
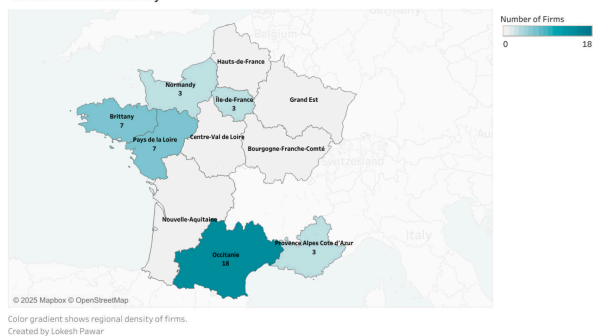
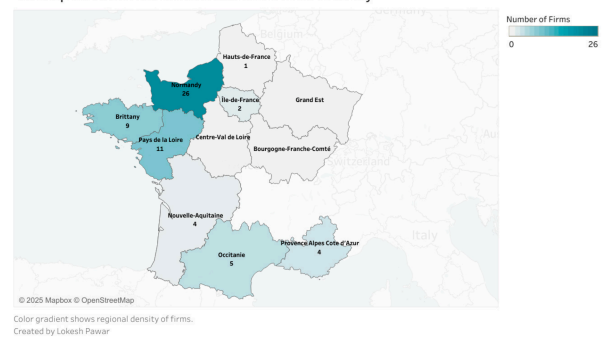


Figure 15. Regional distribution of local firms in the French offshore wind industry by service category: O&M providers, marine & logistics providers, financial institutions & investors, and technical & environmental consultants.

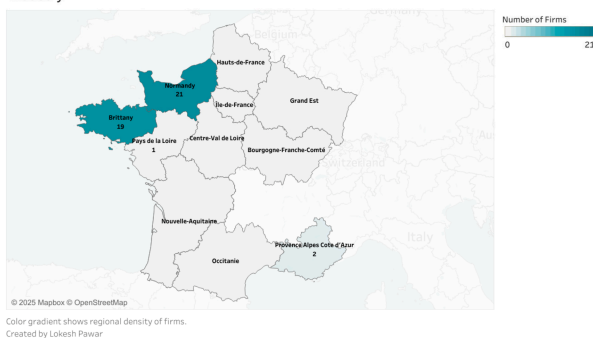
Regional Distribution of Local Research, Education and Training Involved in Offshore Wind Industry



Regional Distribution of Local Institutional Actors: Public actors, Regulators, Certification Body, Local Authorities, Local economic Development Actors Involved in Offshore Wind Industry



Regional Distribution of Local Tertiary Services Involved in Offshore Wind Industry



Regional Distribution of Local All Involved in Offshore Wind Industry

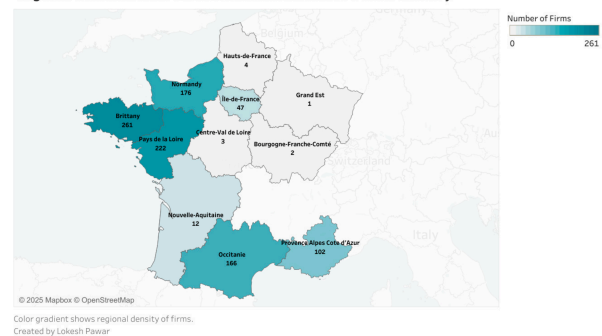


Figure 16. Regional distribution of local institutions and supporting actors in the French offshore wind industry: research & education, institutional actors, tertiary services, and combined all-actor overview.

Underrepresented Regions and Gaps in Participation

Inland and less industrialized regions such as Grand Est, Centre-Val de Loire, and Bourgogne–Franche–Comté show minimal offshore wind sector involvement, attributed to geographic constraints and lack of policy incentives. These areas represent untapped potential, especially for non-coastal manufacturing and technical services. Notably, local financial institutions and investors are sparsely represented, with a maximum of five firms in Normandy, indicating a centralized financing model that may limit local value retention and reinvestment. Tertiary services are also underdeveloped outside key regions, potentially constraining project administration and stakeholder engagement capacities.

3.2.4. Employment Growth and Regional Labour Distribution in the French Offshore Wind Sector

National Employment Growth: Accelerating Workforce Expansion

From 2019 to 2023, full-time equivalent (FTE) employment in the French offshore wind sector nearly tripled, rising from 2690 to 7840 FTEs (Figure 17). A 73% surge between 2019 and 2020 reflects increased project approvals, early-stage construction, and port-based manufacturing. Sustained annual growth of approximately 12% in 2022 and 2023 indicates maturation of supply chains and stable long-term employment beyond initial project surges, aligning with scaling deployment and national energy targets.

Regional Distribution of Employment: Coastal Concentration and Industrial Clustering

Employment is geographically concentrated in coastal and industrialized regions (Figure 18). Pays de la Loire leads with 2498 FTEs, driven by manufacturing, port logistics, and offshore infrastructure deployment. Normandy follows closely with 2264 FTEs, reflecting its role as a logistics and coordination hub. Île-de-France accounts for 1624 FTEs, despite being inland, likely due to corporate headquarters, engineering, finance, and project

management roles. Brittany (543 FTEs) and Sud PACA (460 FTEs) contribute substantively, the former through component manufacturing and the latter through supplier networks. Conversely, regions such as Centre-Val de Loire, Nouvelle-Aquitaine, and Auvergne–Rhône–Alpes show minimal engagement, mirroring earlier findings on firm participation and signalling spatial disparities in workforce opportunities.

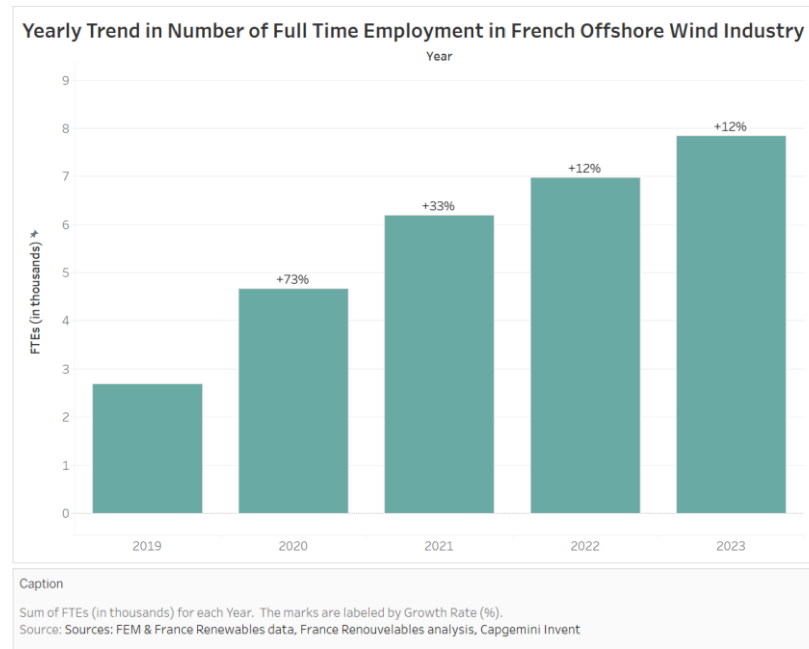


Figure 17. Yearly Trend in Full-Time Employment (FTEs) in the French Offshore Wind Industry (2019–2023), with Annual Growth Rates.

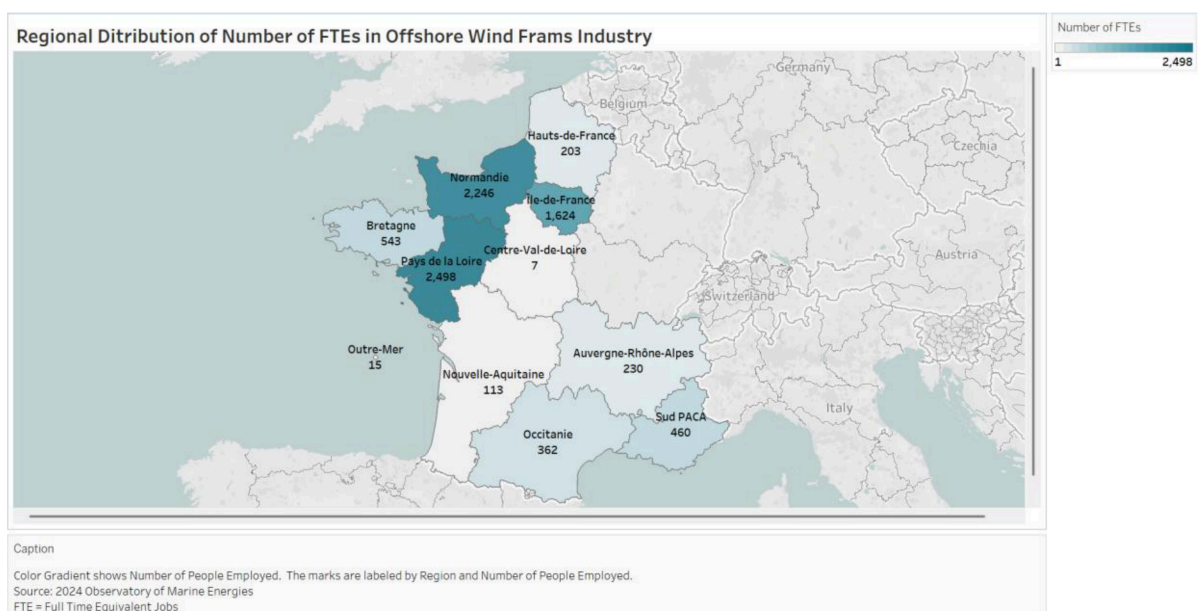


Figure 18. Regional Distribution of Full-Time Equivalent (FTE) Employment in the French Offshore Wind Industry (2024).

3.3. Comparative Spatial Economic Analysis of the Two Sectors

3.3.1. Concentration and Co-Location

The maps presented in Sections 3.1 and 3.2 show two distributions; the statistics in Table 4 establish how they differ. Fishery revenue and offshore wind employment are

similarly concentrated on the leading three regions, with concentration ratios of 0.706 and 0.767, respectively, but they are not equally unequal overall. The Gini coefficient for offshore wind employment is 0.587 against 0.416 for fishery revenue, a difference driven by the long tail of regions with negligible offshore wind participation: Centre-Val de Loire records 7 FTE and Grand Est one mapped firm, whereas every coastal region records material fishery revenue. Offshore wind is thus the more spatially selective sector, notwithstanding that both are dominated by the Atlantic seaboard. The Herfindahl–Hirschman index is, by contrast, marginally higher for fisheries (0.249 against 0.213 for employment), reflecting the singular weight of Brittany, which alone accounts for 42.3% of national first-sale revenue.

Table 4. Concentration of regional benefit distribution in the two sectors. HHI = Herfindahl–Hirschman index on regional shares; CR3 = combined share of the three leading regions; NAMO share = combined share of Brittany, Normandy, and Pays de la Loire. Statistics computed on the regional data underlying Figures 1, 14–16 and 18.

Variable	Regions (n)	HHI	Gini	CR3	NAMO Share (%)
Fishery landings (t, 2023)	7	0.273	0.476	0.770	73.3
Fishery first-sale revenue (M EUR, 2023)	7	0.249	0.416	0.706	70.6
Offshore wind firms (all 11 categories)	9	0.196	0.491	0.672	67.2
Offshore wind employment (FTE, 2024)	11	0.213	0.587	0.767	63.7

Co-location between the sectors is positive but of uneven strength depending on the variable used. Across the five regions for which both series are available, fishery first-sale revenue and offshore wind firm counts are strongly rank-correlated (Spearman $\rho = 0.90$, $n = 5$, $p = 0.037$). Across the seven regions for which fishery revenue and offshore wind employment can both be observed, the association is weaker and not statistically distinguishable from zero ($\rho = 0.50$, $n = 7$, $p = 0.253$). Both coefficients rest on very small numbers of spatial units and are reported as descriptions of the population of French coastal regions rather than as inferential tests. Their substantive reading is that industrial presence tracks the maritime economy closely, while employment does not, and the reason for that divergence is the subject of the next subsection.

3.3.2. Firm Presence Is Not Employment: The Central Empirical Finding

The most consequential result of this study is a divergence that neither sector map reveals on its own. Brittany hosts 26.6% of all mapped offshore wind firms but only 6.5% of national sectoral employment, a ratio of 2.1 full-time equivalents per mapped firm. Île-de-France, which has no operational relationship to any turbine site, hosts 4.8% of firms but 19.6% of employment, a ratio of 34.6 FTE per firm. Pays de la Loire (11.3 FTE per firm) and Normandy (12.8 FTE per firm) sit between these poles, above the national average of 8.5, while Occitanie replicates the Breton pattern at 2.2 FTE per firm. Two conclusions follow. First, firm counts alone, which are the variable most SEBA applications have relied on, systematically misrepresent where employment benefit accrues; a region can be dense in registered participants and thin in jobs. Second, the divergence is itself the measurable signature of the registered-address effect identified in Section 2.6, since large corporate entities register at administrative centres while small consultancies and suppliers register where they operate. Reporting the two layers together, rather than either alone, is

therefore a methodological requirement rather than a refinement, and it is proposed here as a standard element of future SEBA applications.

3.3.3. Quantifying the Trade-Off

The trade-off between the sectors can be given magnitude rather than left as description, using the fiscal instrument that formally links the two. At the 2024 rate of 19,890 EUR per MW, a 496 MW farm such as Yeu–Noirmoutier or Saint-Brieuc generates 9.87 million EUR per year in offshore wind tax. Where the installation lies within the Domaine Public Maritime, the 35% share allocated to fishery committees amounts to 3.45 million EUR per year. Set against the 442 million EUR of annual first-sale revenue landed in the three NAMO regions, this represents 0.78% of the sector’s regional turnover, or approximately 469 EUR per year for each of the roughly 7370 full-time equivalents employed in the adjacent maritime zones. Where the installation lies in the Exclusive Economic Zone, the corresponding figures are zero. The compensation architecture therefore transfers to the fishery sector a sum equivalent to well under one percent of its regional turnover in the most favourable case, and nothing at all in the case that will predominate as deployment moves further offshore into the BGL and CAGL zones.

A second quantification concerns labour. Between 2019 and 2023 the offshore wind sector added 5150 full-time equivalents nationally, while over the preceding decade fisheries lost 964. At national aggregate level, offshore wind job creation therefore exceeds fishery job loss by a factor of more than five. This aggregate is, however, precisely what the spatial analysis contradicts: of the 5150 jobs created, 19.6% of the sectoral total sits in Île-de-France and only 6.5% in Brittany, the region bearing 42.3% of the fishery exposure. The trade-off is thus not adverse in aggregate and adverse in distribution, which is the distinction that aggregate economic assessment cannot make and that motivates the use of SEBA as shown in Table 5.

Table 5. Comparative socioeconomic profile of capture fisheries and offshore wind energy in mainland France, synthesizing the results reported in Sections 3.1–3.3.

Dimension	Capture Fisheries	Offshore Wind Energy
National employment	9162 FTE (2022)	7840 FTE (2023)
Employment trend	−9.5% over 2012–2022 (compound annual rate −1.0%)	+191% over 2019–2023 (compound annual rate +30.7%)
Inequality of regional benefit distribution (Gini)	0.42 (first-sale revenue)	0.59 (employment)
Position of benefit relative to the marine impact zone	Entirely coastal; every euro of first-sale revenue is landed in a region adjacent to the fishing ground	Partly extra-coastal; Île-de-France captures 19.6% of national sectoral employment
Mobility of assets and beneficiaries	Low: vessels, quota entitlements and auction centres are place-bound	High: high-value components are largely imported, and corporate domicile is decoupled from the project site
Financial position	Structurally loss-making without subsidy; net profit negative every year 2019–2022 despite GVA of 700–800 million EUR	Expanding, supported by tendered price guarantees and public de-risking of site investigation
Value-chain structure	Domestic and fragmented; 90.5% of vessels were under 12 m in 2023, up from 81.5% in 2000	Transnational and concentrated in a small number of OEMs and EPC contractors

Table 5. *Cont.*

Dimension	Capture Fisheries	Offshore Wind Energy
Formal fiscal return to the territory	Indirect, through EMFAF and national support schemes	19,890 EUR per MW per year, of which 35% is allocated to fishery committees only if the installation lies within the DPM, and 0% if it lies in the EEZ
Standing in the MSP process	Consultative	Prioritized through strategic zoning, pre-assessment, and accelerated permitting

3.3.4. Sensitivity of the Comparative Results

The comparative findings were tested against the data limitations set out in Section 2.6. Reassigning all 47 multi-role firms from the largest to the smallest region, an extreme and implausible scenario, moved the Herfindahl–Hirschman index for firm counts from 0.196 to 0.176 and the Gini coefficient from 0.491 to 0.428, leaving the identity and rank order of the three leading regions unchanged. Excluding all Tier C entries reduced total mapped firms but altered no regional rank. Withholding each data source in turn likewise left the top-three ordering intact in both sectors. The firm-to-employment ratios reported in Section 3.3.2 are the least sensitive results in the study, because they are ratios of two independently sourced layers and an error common to both cancels. Absolute firm counts are the most sensitive and should be read as lower bounds; for this reason, all statements in this section are expressed as shares.

Coexistence Measures at Yeu–Noirmoutier

Following consultation with fishers, the operator reduced the number of turbine rows from eight to five and aligned them with the prevailing current direction [42]. Approximately 30% of the 496 MW zone remains accessible to vessels under 24 m, and cable routes were re-specified to avoid the principal fishing grounds by landed value [32,42].

4. Discussion

4.1. Sectoral Interactions: Socioeconomic and Spatial Analysis

The spatial decoupling documented here is substantial and directly measurable. Île-de-France, which has no operational relationship to any turbine site, captures 19.6% of national offshore wind employment, whereas every euro of fishery first-sale revenue is landed in a region adjacent to the ground that produced it. Comparable rescaling of renewable energy benefit towards administrative centres has been documented in the United Kingdom [36], where the devolution of energy governance did not by itself relocate the associated economic activity. The centralized corporate geography of France therefore disadvantages coastal regions unless MSP, or more precisely the tendering instruments that follow it, explicitly scores regional supply chain integration at the point of award. Without such mechanisms, the NAMO region risks replicating the extractive spatial pattern critiqued in the environmental justice literature [14], in which benefits flow to capital centres while burdens, namely fishing displacement and visual impact, remain local.

Mapping offshore wind enterprises at both national and regional scales reveals a significant concentration of economic benefits in regions such as Île-de-France and Pays de la Loire, which are geographically distant from the marine areas hosting turbine installations. This spatial disjunction underscores persistent challenges in achieving territorial equity in the distribution of economic gains. Simultaneously, the fishery sector is characterized by declining fleet sizes, deteriorating financial viability, and reduced activity at auction centres,

signalling not only economic distress but also an escalating risk of spatial marginalization within MSP frameworks.

One qualification governs the reading of this entire section. The co-location of offshore wind development and fishery vulnerability is an observed spatial association, not a demonstrated causal relationship. Both sectors concentrate on the Atlantic seaboard because both depend on productive continental-shelf waters and established port infrastructure, and the contraction of French fisheries was well advanced before the first commercial turbine was commissioned in 2022: the fleet had already fallen by 29% between 2000 and 2023 and employment by 9.5% between 2012 and 2022, under pressures from quota regimes, fuel costs, generational renewal and market structure that have nothing to do with offshore wind. What the evidence supports is the narrower and still consequential claim that offshore wind constitutes an additional spatial pressure on a sector whose capacity to absorb further constraint is already exhausted. It is the interaction between a new claim on space and a pre-existing fragility, rather than the new claim in isolation, that makes the distributive question urgent.

Placed alongside earlier European work, these results are both consistent and distinct. The original SEBA applications in the Baltic under BONUS BaltSpace [13] established that beneficiary mapping is feasible and useful but examined one sector at a time at national scale, so they could not detect the firm–employment divergence reported in Section 3.3.2, which is visible only when two independently sourced layers are read against each other. Studies of offshore wind conflict resolution in Denmark, England and the Netherlands [23] show that comparable MSP obligations produce markedly different mitigation practice depending on the permitting instruments that follow the plan; the French case examined here supports that conclusion from the benefit side, since the decisive variable is not the façade plan but the fiscal rule distinguishing the DPM from the EEZ. Work on the spatial squeeze in United Kingdom waters [22] and on the modelling of displacement [21] documents the burden side of the same relationship in greater depth than is attempted here, while spatially explicit Bayesian approaches applied in the Adriatic [24] achieve the uncertainty propagation that SEBA lacks. The distinctive contribution of the present study is therefore not analytical sophistication but coverage: it is, to our knowledge, the first application to map the beneficiary structure of an expanding and an incumbent sector simultaneously, at two nested scales, in a jurisdiction without a centralized marine economic database.

4.2. Explaining the Spatial Patterns: Industrial Structure, Value Chains and Governance

4.2.1. Four Mechanisms Underlying the Observed Distribution

Describing where benefits fall is only the first step; the more useful question is why they fall there. Four mechanisms, operating at different levels, account for the patterns reported in Section 3.

The first is the modularity and tradability of the offshore wind value chain. High-value segments, namely turbine nacelles and blades, monopile and jacket foundations, high-voltage cable systems and installation vessels, are produced by a small number of globally competitive suppliers and are physically transportable. Only the segments that cannot be traded, such as port handling, marine logistics, operations and maintenance and environmental survey work, are necessarily local. The Saint-Brieuc, Saint-Nazaire, and Yeu–Noirmoutier project maps (Figures 10–12) are consistent with this possible explanation: French firms concentrate in coordination, grid and environmental roles while turbines, foundations and cables are sourced from Spain, Italy, Denmark, Belgium and, in one case, China. Fisheries have no equivalent tradable segment. The catching operation cannot be relocated away from the resource, and the first point of sale is by regulation and by

logistics a coastal auction centre, which may help explain why fishery benefits appear more spatially concentrated along the coast, whereas offshore wind benefits are more geographically dispersed.

The second is the possible role of corporate fiscal geography. French corporate registration concentrates headquarters and administrative functions in Île-de-France irrespective of where operations occur, and the offshore wind sector, being capital-intensive and project-financed, has an unusually large administrative, engineering-design and financial component. This may contribute to the observed difference of 34.6 FTE per mapped firm in Île-de-France against 2.1 in Brittany. The mechanism is important for interpretation because it suggests that part of the apparent spatial decoupling may reflect where employment is declared rather than where work is performed. It is not, however, purely an artefact: engineering design, financing and project management are genuinely centralized functions and genuinely well paid, so the benefit may remain economically significant even where its recorded location does not precisely correspond to the location of work performed.

The third is the potential influence of tender design. French offshore wind has been allocated through competitive calls in which price has carried decisive weight and local content has entered, when at all, as a qualitative commitment rather than a scored and enforceable criterion. Such a framework could encourage a developer minimizing levelized cost to procure high-value components from the cheapest qualified global supplier, which is a rational response and not a failure of goodwill. The contrast with Scottish leasing, where regional supply chain commitments are formally assessed, suggests that procurement and tender design may represent a governable factor rather than a purely structural constraint. The Yeu–Noirmoutier subcontractor directory, in which the operator voluntarily documented more than 140 contracts with regional firms, provides an illustrative indication of what may be achievable and of the potential fragility of approaches based on voluntary disclosure.

The fourth is the possible asymmetry of representation embedded in the planning process itself. Offshore wind enters MSP as a national strategic objective with quantified capacity targets, dedicated zoning, pre-assessment, and accelerated permitting. Fisheries enter as a consulted interest with no quantified spatial entitlement and, as Section 4.6 sets out, no spatially disaggregated evidence base of its own. This difference in the availability and institutional status of spatial evidence may contribute to an uneven representation of sectoral interests in planning processes. A sector that cannot demonstrate its economic geography may therefore be structurally disadvantaged in a process that allocates space on evidence, although this interpretation should be regarded as a possible explanation rather than a directly tested causal mechanism. In this respect, beneficiary mapping may help to make otherwise less visible spatial and economic relationships more explicit.

4.2.2. Implications for Local Economies and Regional Development

The spatial distribution of firms underscores offshore wind as both an energy transition tool and a catalyst for regional economic development. Regions with dense, diverse ecosystems—Brittany, Pays de la Loire, Normandy are positioned to realize benefits including job creation, industrial diversification, revenue retention, skills development, and institutional strengthening. The presence of tertiary services and institutional actors enhances regional resilience by extending value creation beyond physical construction to permitting, compliance, communication, and innovation. Conversely, disparities in firm distribution risk exacerbating spatial inequalities absent targeted policy interventions.

4.2.3. Strategic Insight into Maritime Spatial Planning and Policy

MSP frameworks must integrate economic geography and industrial capacity to safeguard socioeconomic benefits. The multi-dimensional mapping presented here identifies mature industrial zones requiring marine access and infrastructure, regions needing targeted support, opportunities for cross-regional collaboration linking inland and coastal economies, and guidance for directing regional development funding. A spatially explicit, sectorally diverse understanding of the offshore wind industry is essential for crafting inclusive, sustainable maritime policies that simultaneously advance climate and economic objectives.

4.2.4. Labour as a Development Indicator

Employment growth outpaces project commissioning, indicating job creation precedes deployment, particularly in manufacturing, planning, and installation preparation. This supports offshore wind's role as a proactive economic stimulus. Regional employment disparities align with firm distribution, emphasizing dependency on local industrial ecosystems. The significant employment share in Île-de-France highlights the critical role of non-coastal regions in governance, R&D, and finance, often underrepresented in blue economy narratives. Policymakers must balance clustering efficiencies with inclusive workforce development to prevent exacerbation of interregional inequalities, especially as floating wind expands into new geographic areas.

4.2.5. Policy and Planning Implications

Employment trends affirm offshore wind as a viable sector for job creation with pronounced benefits in coastal industrial hubs. However, spatial imbalances necessitate targeted workforce development programmes in underrepresented regions, establishment of decentralized skills hubs near future floating wind sites, and integrated planning between regional economic authorities and national energy agencies. Aligning labour strategies with spatial planning and supply chain development will enhance regional integration and sectoral inclusivity, supporting France's offshore wind transition.

4.3. Coexistence, Trade-Offs, and Power Asymmetries

MSP in multi-use marine environments must navigate pronounced asymmetries in power between capital-intensive, state-supported industries like offshore wind and historically entrenched, economically vulnerable sectors such as fisheries. In overlapping zones such as NAMO, spatial competition intensifies. Fishery stakeholders frequently lack the political influence and financial capacity necessary to meaningfully shape MSP decision-making processes; their mandated participation in public consultations is often perceived as tokenistic rather than substantive. The Yeu–Noirmoutier offshore wind project exemplifies a proactive mitigation approach, wherein the developer EMYN engaged local fishers to revise turbine layouts and navigation corridors, reducing turbine lines from eight to five and aligning infrastructure with prevailing currents. Approximately 30% of the wind farm area remains accessible to professional fishers, and submarine cable routes were modified to avoid critical fishing grounds [42,43]. While this case represents a significant stride toward coexistence, such mitigation remains exceptional and lacks systemic integration within national MSP protocols.

Compensation mechanisms further illuminate sectoral power imbalances. At Yeu–Noirmoutier, financial recompense was provided based on estimated turnover losses, with vessels receiving up to 60% of lost earnings depending on the duration of impact and vessel displacement. Although this approach may mitigate short-term economic losses, it does

not address long-term displacement risks or ensure the intergenerational sustainability of fisheries.

Fiscal Distribution and Compensation Mechanisms in Offshore Wind Development Economic benefits accruing to local authorities from offshore wind development are formalized through fiscal instruments, including a sector-specific tax and occupation fees for the use of the *Domaine Public Maritime* (DPM) and *Terrestrial Public Domain* (DPT). For 2024, the offshore wind tax is set at 19,890 EUR per MW, with occupation fees varying according to infrastructure location. Projects situated within the DPM generate fiscal revenues distributed among coastal municipalities (50%), fishery committees (35%), biodiversity protection initiatives (10%), and maritime safety (the remainder) [44]. However, installations located within the *Exclusive Economic Zone* (EEZ) allocate 100% of these revenues to the national government, thereby limiting local benefit retention [45].

While these fiscal mechanisms aim to align economic contributions with spatial impacts, they institutionalize a hierarchy of beneficiaries. Coastal municipalities benefit only when projects are within visual proximity, whereas offshore projects in the EEZ yield no direct economic returns to local communities or fishery stakeholders, despite these groups bearing environmental and operational externalities.

This fiscal framework lacks a spatial justice perspective; revenues are not systematically reinvested into affected sectors, nor is there an established monitoring system linking fiscal flows to socioeconomic outcomes within MSP. Extending the SEBA framework to incorporate fiscal dimensions could facilitate such monitoring by visualizing the spatial distribution of economic benefits relative to zones of impact.

4.4. Role of MSP in Balancing Competing Uses

France's MSP framework is notable for integrating ecosystem-based management principles and aligning with European Union climate objectives; however, its capacity to mediate competing sectoral interests remains constrained. Offshore wind development benefits from institutional prioritization through strategic zoning, environmental pre-assessments, and expedited permitting processes. In contrast, fishery participation tends to be reactive and consultative rather than co-productive in MSP decision-making.

Current MSP processes emphasize spatial efficiency but inadequately address distributional equity. The absence of standardized methodologies for assessing socioeconomic trade-offs perpetuates the marginalization of low-capital sectors. Tools such as SEBA offer critical potential to rebalance these dynamics by rendering visible the spatial distribution of benefits and burdens through detailed economic mapping.

4.5. Evaluating SEBA's Effectiveness and Limitations

The SEBA tool effectively maps sector-specific economic benefits and highlights inequalities in benefit distribution, providing valuable spatial insights. Its principal strength lies in identifying geographic concentrations of economic participation and revealing gaps. Nonetheless, SEBA's utility is constrained by three data gaps: (1) Employment aggregated at NUTS-2 (regional) rather than LAU (municipal) level, preventing intra-regional equity analysis (e.g., coastal vs. inland disparities within Brittany). (2) Subcontractor lists incomplete for 6 of 9 offshore wind projects (only Yeu–Noirmoutier disclosed full supply chain; others withheld commercially sensitive data). (3) Fiscal revenues not spatially tracked (EEZ revenues pooled nationally; [46], Article 5.3). These gaps addressable via regulatory mandates currently limit SEBA's resolution for community-scale MSP. The absence of a centralized marine sector database in France, particularly concerning employment and subcontracting, restricts comprehensive application.

SEBA's static design mapping current distributions reflects its original purpose: facilitating stakeholder dialogue via visualized equity gaps [13]. Projecting future distributions requires coupling SEBA with dynamic models. SEBA outputs feed into agent-based models of fleet behaviour, simulating employment shifts under 10 GW floating wind scenarios (2030–2035). This hybrid approach SEBA for equity audits, ABM for projections is recommended for next-generation MSP tools. Integration with scenario-based planning tools and participatory GIS platforms could enhance its predictive and policy-relevant functions.

Of the limitations identified, the one with the greatest bearing on the results is the absence of employment data below NUTS-2 level. It is the binding constraint because the central finding of this study, the divergence between firm presence and employment, raises immediately the question of whether the employment recorded in Pays de la Loire accrues to Saint-Nazaire and its neighbouring communes or to inland Nantes, and the available data cannot answer it. Every other limitation degrades precision; this one leaves a policy-relevant question formally unanswerable. Incomplete subcontractor disclosure ranks second, but its direction is known: it understates small local firms, so the local benefit share reported here is a lower bound.

The regional resolution of the analysis can nonetheless be partially tested. The Yeu–Noirmoutier subcontractor directory, the only French dataset resolving offshore wind participation below regional level, places approximately 100 firms across the communes of Pays de la Loire (Figure 13), with visible clustering around the Nantes–Saint-Nazaire estuary and the Vendée coast rather than an even regional spread. Two implications follow. The between-region conclusions of this study survive disaggregation, since the sub-regional evidence confirms rather than contradicts the concentration of activity in the region identified as a hub. The within-region conclusions do not: at commune level the distribution is markedly more unequal than the regional figures suggest, which means the Gini coefficients in Table 4 should be read as lower bounds on true spatial inequality. Any claim in this paper about equity between regions is therefore supported at finer scale, and any claim about the benefit accruing to a region as a whole is not.

No direct stakeholder validation was undertaken. No interviews were conducted with fishers, developers, regional committees or planning officials, and no workshop was held to test the interpretation of the maps with those they describe. The consequence is specific rather than general. The factual layers, which derive from public registries and official statistics, do not depend on stakeholder confirmation. The interpretive claims do: the characterization of fishery participation as tokenistic, the reading of the Yeu–Noirmoutier measures as exceptional, and the inference that spatial decoupling is experienced as inequitable all rest on documentary evidence and on insights gathered informally at professional workshops attended by the first author, not on systematic elicitation. These claims should be treated as hypotheses generated by the mapping rather than as validated findings, and the study cannot speak to perceptions of procedural or recognitional justice at all.

Stakeholder input could be incorporated quantitatively in future applications rather than appended as consultation. Three routes are practicable. Participatory weighting would ask sectoral representatives to assign relative importance to indicators, converting Table 2 from an analyst's judgement into an elicited and contestable one. Perceived-benefit mapping would collect, at port or commune level, the share of a project's benefit that respondents believe accrues locally, allowing a direct comparison between recorded and perceived distributions whose divergence is itself a governance indicator. Structured scoring of participation, for instance along a ladder from information to co-decision applied to each consultation event in a DSF cycle, would render procedural equity measurable alongside distributive equity. All three are compatible with the existing workflow and would require no change to the underlying database.

Incorporating environmental indicators would change the interpretation of these results in a specific and asymmetric way. Offshore wind delivers a benefit that is global and diffuse, namely avoided emissions, while imposing costs that are local and spatially concentrated; fisheries impose costs that are ecological and diffuse, through benthic disturbance and stock pressure, while delivering benefits that are local and concentrated. Adding environmental variables to the ledger would therefore strengthen the case for offshore wind in aggregate welfare terms while leaving the distributive finding of this study entirely intact, because carbon abatement accrues to no region in particular. That is precisely the point at which distributive and aggregate analysis diverge, and it is why the two should be conducted separately and read together rather than merged into a single index. A practical articulation would overlay SEBA benefit surfaces on cumulative-effects pressure layers to produce an explicit benefit-to-burden ratio by spatial unit, which is proposed here as the most tractable next development of the framework.

The framework can support scenario analysis, but only in coupled form. SEBA itself is static by design, mapping a distribution at a point in time in order to make it contestable. Prospective use requires linking its outputs to a model that generates counterfactuals: an agent-based representation of fleet behaviour to project displacement and effort reallocation under alternative build-out pathways, or an input–output layer to translate contracted capacity into projected regional employment. Applied to the French case, such a coupling would allow the 8200–8760 MW projected for 2034 to be distributed across regions under contrasting tender designs, for example, with and without a scored local content criterion, and the resulting benefit distributions compared against the fishery vulnerability layers reported here. The hybrid architecture, with SEBA performing equity audits and a dynamic model performing projection, is the recommended direction for the next generation of MSP decision support tools.

4.6. Gaps in Spatial Data and Planning Practice

A persistent challenge within France's MSP framework is the insufficiency of spatially explicit socioeconomic data. While ecological and technical datasets have become increasingly robust, data related to regional employment, fiscal redistribution, and compensation remain fragmented and opaque. Although localized compensation schemes such as those implemented in Yeu–Noirmoutier are documented, they are neither systematized nor available for comparative analysis.

Furthermore, the centralization of fiscal revenues from offshore wind projects in the EEZ accentuates the disconnect between spatial impacts and economic returns. Without mechanisms to spatially trace economic benefit distribution, MSP risks perpetuating existing inequities rather than redressing them. The SEBA framework, if adapted and expanded, offers a replicable methodology to evaluate spatial equity and institutional accountability, thereby supporting more just and transparent MSP governance.

4.7. From Maps to Decisions: Operationalising SEBA Outputs in MSP Practice

A recurrent weakness of decision support tools in MSP is that their outputs are interesting without being usable. Table 6 therefore sets out, for each output generated here, the decision it can inform, the instrument through which that decision is taken in France, and the authority responsible. The mapping is deliberately conservative: every instrument listed already exists, and none of the proposed uses requires new legislation or new data collection.

Three applications warrant elaboration because they are immediately actionable. The first concerns tender design. The forthcoming AO10 round covering the BNO zone will be awarded before the next DSF revision, and the firm and employment maps provide the

empirical basis for a scored regional supply chain criterion. Because the analysis identifies which value chain segments are already densely represented in Brittany, namely technical and environmental consultancy, operations and maintenance and marine logistics, and which are absent, chiefly component manufacture and project finance, a criterion can be calibrated to what the regional economy can realistically supply rather than set as an arbitrary percentage that either binds trivially or cannot be met.

Table 6. Operational use of SEBA outputs in the French MSP system, mapping each analytical output to the planning decision it informs, the existing instrument through which that decision is taken, and the responsible authority.

SEBA Output	Decision It Informs	Instrument and Stage	Responsible Authority
Regional firm and employment maps by value chain role (Figures 14–16 and 18)	Setting regional supply chain and workforce targets, and scoring bids against them	Appel d’Offres tender specification and award criteria	DGEC/Ministère de la Transition Écologique
Ratio of employment share to firm share (Section 3.3.2)	Distinguishing genuine industrial anchoring from registered corporate presence when assessing local benefit claims	Socioeconomic annex of the DSF, six-yearly revision	Conseil Maritime de Façade
Fishery dependency; fleet and employment layers (Figures 2–4)	Prioritizing zones for exclusion, seasonal access windows, or targeted mitigation	DSF zoning; identification of BNO, BNE and BGL perimeters	DGAMPA; CNDP for the public debate stage
Auction-centre network and fleet trajectory (Figures 4 and 5)	Directing investment towards landing infrastructure at risk of falling below viable throughput	EMFAF operational programme	FranceAgriMer; Regional Councils
Fiscal flow mapping, DPM versus EEZ (Section 3.3.3)	Reforming the territorial allocation of the offshore wind tax so that benefit retention does not vanish with distance from shore	Annual finance law; DPM occupation fee schedule	DGFIP; DGAMPA
Commune-level subcontractor directories (Figure 13)	Verifying, after consent, that local content commitments made during consultation have been honoured	Consent conditions and annual operator reporting	Préfecture maritime; DREAL

The second concerns compensation. Current compensation at Yeu–Noirmoutier is calculated from estimated turnover loss for individual affected vessels, at up to 60% of lost earnings. The vulnerability layers assembled here support a complementary, territorially based instrument: allocating a share of the offshore wind tax to the harbours whose dependency indicators, comprising landings concentration, fleet age structure and auction-centre reliance, place them above a defined risk threshold, rather than only to the vessels whose grounds are directly overlapped. This distinction matters because displacement effects propagate through a port economy well beyond the vessels physically excluded, and because Section 3.3.3 shows that the sums currently transferred are equivalent to under one percent of regional first-sale revenue.

The third concerns the DSF revision cycle itself. French façade documents are revised every six years, and the socioeconomic component of the current generation is acknowledged to be descriptive. The indicator set in Table 2 is constructed entirely from sources already held by French public bodies and could be adopted as a standing socioeconomic annex, recomputed at each revision from the same registries. Because the visualization

platform is open and updatable, the marginal cost of doing so after the first cycle is close to zero, and the resulting time series would allow planners to observe whether the distributive gap identified here narrows or widens as deployment proceeds. That, rather than any single map, is the practical contribution the framework offers.

4.8. Transferability to Other Regions and Governance Systems

Two questions of generalization should be distinguished. The first is whether the method transfers, which is largely a matter of data infrastructure and is addressed in Section 2.8: wherever a public business register, consistent production statistics and a plan boundary matching the statistical unit coexist, the workflow applies unchanged. The second is whether the findings transfer, which depends on governance and is more restrictive.

Three features of the French case drive the results and should be checked before the conclusions are carried elsewhere. The first is administrative centralisation. The concentration of corporate domicile in the capital region is characteristic of unitary, centralized states and would be expected to be weaker in federal or strongly regionalised systems; the Danish experience at Horns Rev, where a large majority of employment remained within the immediate region, and Scottish leasing, where regional supply chain integration is formally assessed, both indicate that the decoupling documented here is contingent rather than necessary. The second is the geography of the fiscal rule. The French distinction between the *Domaine Public Maritime* and the *Exclusive Economic Zone*, which extinguishes local benefit retention beyond a defined distance, has no counterpart in jurisdictions that apply community benefit funds irrespective of distance from shore; where that rule differs, the fiscal findings of Section 3.3.3 do not carry over. The third is the composition of the incumbent fleet. NAMO fisheries are dominated by vessels under 12 metres, and the vulnerability documented here is characteristic of small-scale, place-bound fishing. In regions dominated by mobile industrial fleets, displacement is absorbed differently and the distributive question takes a different form.

Within France, extension to the other three façades is straightforward and would be informative for contrasting reasons. The Eastern Channel–North Sea façade combines advanced offshore wind deployment with intense and internationally shared fishing activity, which would test the transboundary integration dimension of SEBA that the present case exercises only weakly. The Mediterranean façade, where floating wind is planned and fisheries are economically marginal, would test whether the framework retains discriminating power when one distribution is close to flat. Comparative application across all four façades would also allow the concentration statistics reported in Table 4 to be benchmarked rather than read in isolation, which is currently the principal constraint on their interpretation.

5. Conclusions

The study critically examined the socioeconomic dimensions of Maritime Spatial Planning (MSP) in France, focusing on the spatial and economic interactions between offshore wind development and the fishery sector. Employing the Spatial Economic Benefit Analysis (SEBA) tool within a mixed-methods, multi-scalar framework, the study elucidated significant disparities in the distribution of economic benefits and revealed systemic challenges undermining equitable marine governance.

Four findings carry the argument. First, the two sectors differ systematically in how unequally their benefits are distributed across regions: offshore wind employment has a Gini coefficient of 0.59 against 0.42 for fishery first-sale revenue, and the difference is produced by regions with negligible wind participation rather than by the leading cluster. Second, and most consequentially for SEBA practice, corporate presence is a poor proxy for employment benefit. Brittany hosts 26.6% of mapped offshore wind firms but 6.5% of

sectoral employment, while Île-de-France hosts 4.8% of firms and 19.6% of employment; firm-count maps alone therefore misstate where benefit accrues, and the two layers must be read together. Third, the sectors are co-located rather than causally linked. Fishery revenue and offshore wind firm counts are strongly rank-correlated across coastal regions ($\rho = 0.90$, $n = 5$, $p = 0.037$), but fishery contraction predates commercial offshore wind deployment by two decades, and offshore wind is properly characterized as an additional spatial pressure on an already vulnerable sector rather than as its cause. Fourth, the fiscal architecture does not correct the imbalance: the fishery share of the offshore wind tax from a 496 MW farm amounts to 0.78% of NAMO first-sale revenue where the installation lies within the Domaine Public Maritime, and to nothing at all once it lies in the Exclusive Economic Zone, which is where future deployment is directed.

Methodologically, the study shows that a distributive question can be answered with data that French planning authorities already hold, without new collection and without confidential material. The extensions introduced here, namely dual-sector comparison, nesting of project-level within regional mapping, explicit indicator selection criteria, tiered treatment of data confidence and delivery through an open updatable platform, are each transferable. The limitations are equally clear: the framework is static, resolves no finer than NUTS-2 for employment, excludes environmental variables by design, and was not validated with the stakeholders whose circumstances it describes. Its interpretive claims should accordingly be read as hypotheses for testing rather than as settled conclusions.

Taken together, these results indicate that France's MSP architecture is advancing in ambition while remaining uneven in its treatment of socioeconomic distribution. Offshore wind is prioritized through zoning, pre-assessment, accelerated permitting and a formalized fiscal channel; fisheries participate consultatively, without a spatially disaggregated evidence base of their own, and are compensated through instruments that address short-term loss rather than long-term displacement. This asymmetry is not an incidental feature of the French case but a predictable consequence of allocating space on evidence when only one sector's economic geography has been mapped.

The SEBA framework proved instrumental in visualizing these disparities by mapping sector-specific economic benefits and revealing the disconnect between areas of environmental impact and zones of economic advantage. However, limitations such as the scarcity of disaggregated, spatially explicit socioeconomic data and the absence of dynamic modelling capabilities constrain its comprehensive application. Integrating SEBA with scenario-based planning and participatory GIS could enhance its policy relevance and predictive power.

Future research should proceed on four fronts. Coupling SEBA outputs to an agent-based model of fleet behaviour would convert a static equity audit into a prospective one, allowing alternative build-out and tender-design pathways to be compared. Participatory mapping workshops with fishers, developers and planners would validate the interpretive claims made here and could be extended, through participatory indicator weighting and perceived-benefit mapping, into a quantitative treatment of procedural equity. Overlaying benefit surfaces on cumulative-effects pressure layers would yield an explicit benefit-to-burden ratio by spatial unit and integrate the environmental dimension excluded here. Finally, comparative application across the remaining three French façades, and to jurisdictions with different degrees of administrative centralisation, would establish whether the firm–employment divergence documented in this study is a French particularity or a general feature of offshore renewable value chains.

Policy implications emphasize the necessity of coupling energy transition strategies with social resilience measures that prioritize small-scale, place-based sectors like fisheries. Strengthening national supply chain anchoring beyond primary contractors and evolving

MSP governance from consultative to co-productive processes embedding local knowledge, comprehensive sectoral data, and equity metrics are critical for addressing spatial inequities.

In conclusion, while France’s MSP framework demonstrates increasing ambition and alignment with climate objectives, its incorporation of socioeconomic dimensions remains uneven and insufficiently spatially explicit. Without deliberate integration of evidence-based, spatially sensitive tools such as SEBA, offshore wind development risks exacerbating existing spatial inequalities and sectoral exclusion. This study advances a vision of marine governance that is both technically robust and socially just, a prerequisite for sustainable ocean use amid intensifying sectoral competition.

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Abbreviations

The following abbreviations are used in this manuscript:

BGL	Bretagne Grand Large
BNE	Bretagne Nord Est
BNO	Bretagne Nord Ouest
CAGL	Centre Atlantique Grand Large
CNDP	Commission Nationale du Débat Public
CRPMEM	Comité Régional des Pêches Maritimes et des Élevages Marins
DAM	Directorate of Maritime Affairs
DGAMPA	Directorate General for Maritime Affairs, Fisheries, and Aquaculture
DPM	Domaine Public Maritime (Maritime Public Domain)
DPMA	Directorate of Maritime Fisheries and Aquaculture
DPT	Domaine Public Terrestre (Terrestrial Public Domain)
DSF	Document Stratégique de Façade
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EDF	Électricité de France
EIAs	Environmental Impact Assessments
EMFAF	European Maritime, Fisheries, and Aquaculture Fund
EMFF	European Maritime and Fisheries Fund
EPC	Engineering, Procurement, and Construction

EU	European Union
FAO	Food and Agriculture Organization
FEM	France Énergies Marines
FTE	Full-Time Equivalent
GIS	Geographic Information System
GVA	Gross Value Added
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
IMBRSea	International Masters in Marine Biological Resources
IUCN	International Union for Conservation of Nature
MARXAN	Marine Reserve Design Tool (spatial optimization software)
MPA	Marine Protected Area
MRE	Marine Renewable Energy
MSP	Marine/Maritime Spatial Planning
NAMO	North Atlantic–Western Channel (French Maritime Façade)
NGO	Non-Governmental Organization
OEM	Original Equipment Manufacturer
O&M	Operations and Maintenance
ORE	Offshore Renewable Energy
OWF	Offshore Wind Farm
PACA	Provence–Alpes–Côte d’Azur
PPA	Power Purchase Agreement
RTE	Réseau de Transport d’Électricité
SDG	Sustainable Development Goal
SEBA	Spatial Economic Benefit Analysis
SNML	Stratégie Nationale pour la Mer et le Littoral
STECF	Scientific, Technical and Economic Committee for Fisheries
TEG	Technical Expert Group (on MSP Data)
UNESCO	United Nations Educational, Scientific and Cultural Organization
€	Euro
VAT	Value-Added Tax

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